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TECHNOLOGY ASSESSMENT OF FUTURE INTERCITY PASSENGER TRANSPORTATION SYSTEMS

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Volume 4

Scenarios

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PREFACE

This document on scenarios developed for the Study is in three parts:

- Part A describes four alternative future states of society or "background scenarios."
- Part B contains descriptions of future intercity transportation systems called "transportation scenarios." One transportation scenario was developed in the Study for each background scenario.
- Part C reports on a quantitative analysis of the transportation scenarios, including patronage estimates for the various postulated intercity systems.

During the study, the three parts of this volume were issued as separate technical reports. They are combined here for ease of reference.

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PART A

BACKGROUND SCENARIOS OF POSSIBLE FUTURE STATES OF SOCIETY

by

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PART A

BACKGROUND SCENARIOS OF POSSIBLE FUTURE STATES OF SOCIETY

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I. INTRODUCTION

This technical report contains descriptions of four background scenarios that relate to alternative states of society in the next 25 to 50 years. The scenarios have been developed for use in analyzing and evaluating alternative future intercity transportation technologies. The scenarios are based, in part, on discussions contained in the issue papers of Volume 2 and, in part, on separate analysis of social and economic trends considered relevant for the evolution of intercity transportation.

Why Scenarios?

This is a good question. The desirability of using scenarios in a technology assessment is debatable. Therefore, the decision to use scenarios in this study requires explanation.

First, it is necessary to emphasize that this study is not an exercise in scenario-building. The scenarios themselves are not major study products; rather, they are simply a device to help produce these products. Also, there is no intention here to guide the country toward the most popular of the described scenarios. The concept that there is one "best" future world that can be articulated, agreed upon, and implemented is contrary to our perception of how historical developments actually occur.

Scenarios are employed in this study to help structure the assessment of alternative future transportation technologies and policies. The scenarios focus attention upon the consequences of uncertainties regarding the future. Assessing the impacts of transportation options, for example, the financial consequences of development of an American supersonic transport (SST), must be based on a host of assumptions concerning external conditions, such as the money market, the nature of environmental regulation, the political climate for public financial assistance, and so on. Varying such external factors one by one to see how uncertainties in each factor affect the financial consequences of the proposed development is an almost endless task. Background scenarios supply a short cut to this sensitivity analysis by providing a consistent way to vary all the relevant external factors at once, thereby yielding insights similar to those learned by laboriously varying the external factors one by one.

Direct forecasting of possible future states of the nation was rejected as an approach because of the lack of credibility inherent in such forecasts. On the other hand, reliance upon haphazard judgments to vary background conditions clearly lacks sufficient rigor. Scenarios are employed as a means to get around the deficiencies of forecasting, and to constrain informed judgment, by providing several

possible, internally consistent, and interestingly different futures against which to study the implications of possible future transportation technologies.

Criteria for Scenarios

The art of scenario writing has acquired a certain amount of procedural rigor during the years, and using scenarios has become popular for planning and policy analysis. Yet, there is no commonly accepted method to develop scenarios; rather, there are a large number of methodological options ranging from single stream-of-consciousness judgments to large computer models of the world.

For this study, an approach was selected that leans more on systematic judgment than quantitative analysis. While some quantitative analysis is included, specifically to obtain reasonable population and economic projections, no effort was made to develop an elaborate social-economic model of the nation, both because the role of scenarios in this study does not justify such an expenditure of resources and because such a model would likely lack sufficient credibility anyway.

An overriding criterion governing scenario development is that all documented aspects of the scenarios should be relevant to the development of intercity transportation technologies, institutions, and services. This immediately raises the question of how broadly focused the scenarios should be in order to cover all the relevant factors but not wander away from the key issues that significantly affect intercity transportation. To approach this question, a quick and rather rudimentary cross-impact analysis was performed very early in the study to help determine which economic, social, and institutional factors should be viewed as driving forces in the scenarios. These factors would be varied arbitrarily and give rise to the basic scenario definition, to which other features of the scenarios would be matched judgmentally. This cross-impact analysis is discussed in Appendix A. The principal result of the analysis is the finding that, for background scenarios to include all that is relevant to intercity transportation, it is necessary that the scenarios be defined in terms of variations in the basic political and ideological mood of the country.

A variety of other criteria were followed to develop the background scenarios. These are itemized below.

- Scenarios must concentrate on trends and events between 1975 and the year 2000, with some consideration of how the scenario would evolve further between 2000 and 2025. This criterion reflects the relative importance of the nearer time horizon, as well as humility concerning our ability to visualize possible conditions over 25 years into the future.

- Scenarios must be believable. A necessary condition for believability is internal consistency. To the extent that we understand how economic and social processes work, these paradigms must not be violated within the scenarios.

- Causality among different features of scenarios should be implied cautiously. Again, this criterion reflects our limited understanding of how many economic and social processes actually work. Generally, the different features of a scenario are together because they do not preclude each other, not because they necessarily imply each other.

- The scenarios should not be polarizing, nor should any scenario seem much more likely than the others. Here, it is assumed that, for the scenarios to serve their purpose, each must be psychologically acceptable as a possible future. No scenario should be so distasteful that people refuse to plan seriously for it, or so utopian that no one takes it seriously. Like the actual world, each scenario should have both good and bad features.

- The scenarios should explicitly recognize that most change is induced by conflicts of one type or another, and that institutionalized change is generally caused by temporary coalitions of traditionally diverse interests.

- The scenarios should reflect a dynamic view of history. That is, society does not evolve uniformly in a single direction, but passes through different phases, occasionally causing major shifts in society's character. While short-term economic cycles and social fads are ignored, major irreversible changes in society are important features of the developed scenarios.

- The scenarios should vary considerably in their implications for intercity transportation. This criterion has had a most profound effect upon scenario development.

- As much as possible, the scenarios should include quantitative information. While it is recognized that many critical future developments, such as regulatory changes or competition for investment capital, cannot be directly quantified, wherever possible, relevant quantitative information is included.

II. DESCRIPTIONS OF BACKGROUND SCENARIOS

Scenario Summaries

Scenario I--National emphasis is on economic development and encouragement of business...Relaxation of many business controls...Slow population growth oriented to suburbs near major cities...Considerable growth in wealth and capital formation...Worsening international tensions, resource cartels, and economic warfare...High capital and resource costs...Considerable R&D and large scale innovation...Privately financed transportation innovations in dense markets, minimal service in sparse markets.

Scenario II--National emphasis is on restraint of big business and big government and encouragement of competition and entrepreneurship... Control of large corporations through forced public disclosure, antitrust, and some nationalization of foundering companies...Steadily increasing population oriented to medium-size and nucleated cities... Moderate growth in wealth and capital formation...Some relaxation of international tensions and favorable trade conditions...High capital and moderate resource costs...Considerable R&D and diffuse innovation... Considerable transportation innovation.

Scenario III--Consensus-oriented political leadership emerges with flexible policies aimed at mediating competing demands of well-organized interest groups...Much planning and adjudication prior to major public and private developments to prevent social and environmental damage and to achieve widest incidence of benefits...Growing complexity and inefficiency in public and private services, with increasing government subsidy in many areas...Slow population growth concentrated in existing cities and suburbs...Extremely slow economic growth...Avoidance of foreign involvement with loss of U.S. dominance in international markets...Moderate capital costs...Moderate resource costs initially, followed by a severe energy crisis in the 1990s... Moderate R&D expenditures with slow implementation of innovations, particularly in the transportation sector.

Scenario IV--A strong political coalition emerges committed to ambitious social and economic reform...Strict government control of key enterprises and eventual government ownership of many...Major growth in public services...Steadily increasing population oriented to medium-size cities and nucleated metropolitan areas...No-growth economic policy...Considerable relaxation of international tensions...Low capital and moderate resource costs, but with heavy taxation of private resource use...R&D closely focussed on national social priorities, yielding significant innovations in energy production and transportation.

Background Scenario I--General Description

Political and Economic Developments. The economic slump of mid-1970s gives rise to a successful business-taxpayer coalition to put the economy "back on the track." Between 1975 and 1985, a number of unpopular business controls are removed (such as "fair trade" laws and various legal barriers to marketplace entry and service integration). Profits, investment, and economic growth rates are high, about 4% per annum, with much of the economy becoming steadily more concentrated within large enterprises.

Throughout the period, government cautiously exercises control to protect and repair the environment and to mount ameliorative social programs. A number of crippling strikes in the late 1970s, largely over job security, lead to federally sponsored manpower-retraining and some public employment programs. Revenue sharing to states and local areas is adequate to provide some slight expansion of existing services. Taxes are moderate. During the 1990s, government begins to become a partner in many major corporations, and business activities are more strictly controlled to promote a variety of domestic social objectives.

International Relations. In an unsettled international climate, groups of resource-rich nations increasingly form OPEC*-like cartels to control prices. The U.S. responds by leading counter-cartels dealing in agricultural commodities. Basic commodities prices are increasingly controlled by political decisions and international commerce is closely manipulated to further political objectives. Foreign purchases of U.S. technology and military hardware grow steadily, often through complex trade agreements to acquire foreign resources.

Periodic coups and insurrections exacerbate international friction. National defense remains an important expenditure, although decreasing slightly in relative share of gross national produce (GNP) over the years.

Demography, Employment and Society. U.S. population grows at a moderate rate, following the Census Series E projection. Most growth is in suburbs near established urban areas; however, there is appreciable downtown development of luxury apartments, attracting numerous wealthy families after child-rearing. Average population age increases.

Automation produces a continuing major employment shift from manufacturing to services. Public service employment remains level. Unemployment remains about 5%. Total personal and disposable income grow at approximately 3% per annum.

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*Organization of Petroleum Exporting Countries.

The U.S. remains a consumption-oriented society, with rapidly increasing expenditures for recreation and related travel. Travel to visit family and friends and to domestic and foreign vacation resorts expands rapidly. While wealth continues to increase, continuing apprehension over foreign economic threats preserves the work and productivity ethic as a central American value.

Technological Trends. R&D is directed toward increasing productivity and developing new products, with a strong emphasis on achieving national resource self-sufficiency. R&D expenditures are high.

Government priority is placed on finding new energy sources, spurred by steadily increasing oil prices. The late 1980s see considerable use of coal for electricity generation. In the 1990s, breakthroughs occur in fusion and fuel cell research. By the mid-1990s, the U.S. is essentially independent of foreign petroleum supplies, and energy prices level off.

Considerable emphasis is placed on developing material substitutes and methods for mineral extraction from the ocean. Despite high costs, rapidly increasing prices of foreign supplies justify the effort, and there are major successes by the mid-1990s, with corresponding price stabilization.

Communications technology advances significantly during the period, particularly for data and document transmission. However, despite developments, there is no net substitution of communications for travel.

Beyond 2000.

- Politics and Economics--Increased involvement of government in the operation of major corporations. Marked slowdown in economic growth with a gradual shift to society-serving, rather than business-serving policies.

- International Relations--Gradual easing of economic warfare.

- Demography, Employment, and Society--Continuing slowdown in population growth with significantly decreased labor force participation. Stable settlement patterns. Continued increase in public service employment. Significantly improved public services.

- Technology--Continued emphasis on exploitation of economical electricity. Improvement of battery technology and electricity transmission capabilities.

Background Scenario II--General Description

Political and Economic Developments. Perceived economic and political misconduct by several major corporations in the early 1970s leads to increasing popular mistrust and hostility toward big business and big government. Following the economic recovery of the mid-1970s, a successful consumer-taxpayer-conservationist coalition backs a reform-minded Congress to enact significant anti-big-business legislation. These laws provide for public representation on corporate boards over a certain size, close scrutiny of operations, and a general tightening of antitrust laws. Strict enforcement of environmental and consumer protection laws impact most heavily on visible, large corporations.

Government policy encourages growth of small and medium-size companies, through tax deferment and favorable treatment of small businesses that compete effectively for government contracts. The last quarter of the century has moderate GNP growth in the United States (about 3% per annum), characterized by an increasingly diverse array of goods and services.

Mistrust of big centralized government encourages state and local authorities to seek local solutions to problems and discourages formation of new federal programs. Revenue sharing is expanded through a new system that better matches funding to needs. Taxes are moderate.

International Relations. Many other countries follow the U.S. lead in controlling activities of large businesses. Building upon an increasingly noninterventionist political posture, the U.S. is successful in promoting freer international trade and healthy competition in international markets. In the mid-1970s, a number of bilateral agreements to trade technology and arms for petroleum and other resources succeeds in permanently breaking the economic power of OPEC and similar cartels.

In the mid-1980s, foreign arms sales are reduced significantly through a major arms limitation agreement. Domestic military expenditures gradually decrease after 1985.

Demography, Employment, and Society. U.S. population grows at a fairly high rate, following the Census Series C projection. Some migration occurs to employment opportunities in medium-size cities. In established urban areas, increased land use control and changes in tax policies lead to increased densities in nucleated cities. Older city centers continue to lose population and employment.

There is a significant continuing shift from manufacturing to services employment. Public service employment grows slightly. Unemployment remains relatively high at about 9%. Total personal and disposable

income increase about 2.5% per annum. Many welfare programs are replaced by the negative income tax.

The U.S. remains consumption-oriented with increasing concern for the underlying quality of life. Self-fulfillment, individuality, and sense of community are increasingly important personal objectives. While work remains an important part of life, pursuit of individualistic forms of leisure gradually increase in priority with visits to far flung family and friends having an important place among leisure activities.

Technological Trends. R&D is vigorous and fruitful in providing new products, improving the environment, conserving resources, and providing reliable sources of energy and materials. Innovations are diffuse and often small-scale. Funding is generous.

A major thrust occurs to develop small-scale recycling and energy systems based on maximum use of renewable resources. Use of waste products, wide-spread application of solar cells, wind power, etc., somewhat reduce the need for large-scale power generation. Coal and coal derivatives are increasingly used as petroleum substitutes. U.S. requirements for imported petroleum decrease steadily through the 1990s. The cost of petroleum remains fairly high, decreasing somewhat after 1990.

Costs of other basic materials climb slowly through the period. Innovations in substitute materials generally head off threatened shortages.

Communication technology is a major beneficiary of innovation. Economical videophone and document transmission capabilities manage to substitute for up to 10% of business travel by the mid-1990s.

Beyond 2000.

- Politics and Economics--A stable society and economy exists during this period with few major changes. A slowdown occurs in economic growth.

- International Relations--Increased international cooperation to improve the worldwide standard of living.

- Demography, Employment, and Society--Departure from the Series C projection to achieve a zero population growth rate. Increased population migration away from crowded areas, facilitated by high quality transportation and communications. Decreasing emphasis on consumption.

- Technology--Continued development of small-scale regenerative systems to permit household and community energy independence. Continued development of communications technology.

Background Scenario III--General Description

Political and Economic Developments. Widespread mistrust of government brought about by the political scandals of the 1970s introduces a period of cautious government behavior and policy. There is steady growth of increasingly well-organized interest groups that espouse competing programs to deal with continuing economic and social problems. Government pursues a role of mediator, promoting compromises that give something to everybody. Unpopular actions, such as restricting use of limited petroleum and increasing strip mining of coal, are deferred. Environmental laws become stricter.

In 1990, there occurs an energy crisis of massive proportions. Popular resentment supports a significant revision of civil law and judicial process to disarm much organized opposition to development. Government adopts strict economic measures to rescue the economy. As the country enters the 21st Century, conditions support resumption of moderate economic growth.

Economic growth to the year 2000 is slow, with real GNP increasing at less than 1.5% per annum. Regulatory law changes little. Increasingly, major companies founder and look to government for subsidy, which is granted on a perceived public need basis, accompanied by increased government control of operations. Taxes are high. Remuneration to organized labor increases faster than productivity, and investment is low.

International Relations. With concern centered on domestic difficulties, U.S. involvement in foreign affairs declines. Government-supported companies from several wealthy countries and cartels of resource-holding nations begin to dominate international trade and politics. Foreign corporations expand into U.S. markets, and by 1990, control many domestic manufacturing and technology enterprises.

National defense continues as an important proportion of federal expenditures.

Demography, Employment, and Society. U.S. population grows at a moderate rate, following the Census Series E projection. Most growth occurs in previously developed portions of metropolitan areas, with steadily increasing land use densities. The numbers of poor and elderly in central cities increase due to the ready availability of social services and an overall aging of the population.

There is a slow shift from manufacturing to service employment. Public service employment increases moderately, with government providing a considerable amount of employment of last resort, keeping unemployment at about 6%. Total real personal and disposable income grow slowly, averaging less than 1% increase per annum.

Prior to the crisis of the 1990s, the U.S. is a comfortable consumption-oriented society, although with uneasiness over the disproportionate influence wielded by vocal interest-groups. Individual economic advantage remains a central concern, particularly during the crisis of the 1990s.

Technological Trends. Prior to 1990, R&D expenditures are moderate and spread among a wide variety of programs, often selected for visibility and political purposes. Implementation of R&D results is difficult and infrequent.

After the energy crisis of 1990, R&D grows and focuses upon creation of petroleum substitutes. By the end of the century, there is a significant shift to electricity generated from coal and nuclear breeder reactors, as well as the beginning of widespread use of coal-derivative petroleum substitutes.

Costs of other imported materials climb slowly through the period, with some use of material substitutes largely developed through private sector research.

Communication technology advances slowly through the period. Industry growth is impeded by class action disputes insisting that current rates be lowered before new services are offered. There is virtually no substitution of communications for travel.

Beyond 2000.

- Politics and Economics--Government exercises firm control over the economy. Economic efficiency, equity, and stability are major criteria for all public programs.
- International Relations--Government actions to restrict foreign control of the U.S. economy lead to increased isolationism.
- Demography, Employment, and Society--Continuing slowdown in population growth and significantly decreased labor-force participation. Stable settlement patterns. Restructuring of social welfare services to eliminate waste and duplication.

- Technology--Continuation in R&D activity closely focused to national needs. Development of fusion power-generation technology by 2020. Major advances in communications technology.

Background Scenario IV--General Description

Political and Economic Developments. In the late 1970s, charismatic political leadership is elected on an anti-big-business, pro-social-welfare platform. Government gradually effects a number of far reaching changes in the American economic and social structure. Through the mid-1980s, economic and political decision-making power is increasingly centralized in Washington. In the interests of consumer protection, and in response to numerous business failures stemming from a no-growth economic policy, the government becomes more and more involved in production and services, ultimately leading to nationalization of certain key segments of the U.S. economy.

In the early 1990s, popular disillusionment over rampant and paternalistic government control leads to a period of grass-roots, but significant, entrepreneurship. By the end of the century, there exists a two-level economy, with major enterprises and infrastructure federally owned or closely controlled, and with numerous small and medium-size businesses competing freely in the private sector.

The economy is strictly managed to pursue social objectives, as defined by the minorities-equity-conservationist coalition in power. Social services are reorganized and expanded significantly. Environmental laws are strictly enforced. Taxes are very high. Economic no-growth is seen as a national objective, with real GNP growth of about 1% closely matching the population growth rate.

International Relations. The U.S. pursues a cautious foreign policy of providing economic assistance to poorer countries, in steadily increasing amounts, while endeavoring to insulate the domestic economy from foreign resource cartels. International trade is strictly controlled to support domestic and foreign policy. Exports of food and civilian technology steadily increase.

U.S. interest in foreign political conflicts becomes increasingly neutral and, more and more, the U.S. is perceived as a good neighbor throughout the world. U.S. military expenditures remain a slowly decreasing portion of the federal budget.

Demography, Employment, and Society. U.S. population grows at a fairly high rate, following the Census Series C projection. Government economic and housing policy encourages growth of medium-size

cities and of nucleated patterns in metropolitan areas. Strict land use controls significantly increase densities in growing cities and decrease densities in older city centers.

Public service employment grows rapidly, both for administration of expanding social services and as employment of last resort for many. There is a steady decline of manufacturing employment in the private sector and some growth in service employment. Unemployment is low, at about 5%, but with relatively little growth in labor force participation. Per capita real personal income decreases somewhat during the period, with after-tax income significantly reduced.

Despite reduced income, standards of living are high due to expansion of nominally priced social services, including health care, counseling, education, arts, and intraurban public transportation. While life is comfortable and very secure in this increasingly paternalistic society, there exists an undercurrent of restlessness, manifested in low participation in the labor force. This restlessness is eased somewhat after the small business resurgence late in the century.

Technological Trends. R&D expenditures are low, but activities are closely focused on national priorities. Within this framework, energy self-sufficiency and transportation are earmarked for emphasis.

A major R&D objective is to find substitutes for imported petroleum and other scarce natural resources. In the 1980s, the government supports a strictly controlled program of offshore oil development, significantly reducing U.S. dependence on foreign petroleum. Also, at this time, stiff taxes are placed on private petroleum use, with exemptions for public use. Electricity development is emphasized, and coal and nuclear energy come increasingly into use, largely eliminating utility and industry dependence on petroleum by the early 1990s. Fusion reactors become a reality by the year 2000. The heavy petroleum taxes are removed near the end of the century.

Costs of other essential raw materials climb slowly through the period. Innovations in substitute materials generally head off threatened shortages.

Communications technology advances slowly throughout the period. There is virtually no substitution of communications for travel.

Beyond 2000.

- Politics and Economics--Firm government control continues, although with small and medium-size private enterprises gradually increasing in importance. Economic efficiency, dependence upon renewable resources, equity, and stability are major criteria for public policy.

- International Relations--Greater political stability with increased international cooperation to improve the worldwide standard of living.

- Demography, Employment and Society--Continued population growth. Stepped up migration away from crowded areas, facilitated by high-quality transportation services. Increased service employment in the private sector.

- Technology--Expansion of fusion electricity generation, supplemented by recycling and regnerative energy systems to further small community resource independence. Increased development of communications technology.

III. COMPARISON AMONG SCENARIOS

This chapter contains a collection of summary tables (Tables 1 to 3) and charts (Figures 1 to 12) to facilitate comparisons among scenarios. In the economic trend charts (Figures 3 through 12), all money values are in constant 1968 dollars except for crude oil prices, which are in constant 1974 dollars.

Table 1

POLITICAL AND ECONOMIC COMPARISONS AMONG BACKGROUND SCENARIOS
1975-2000

	Political and Economic Policy	International Relations	Business Structure	Social Welfare	Environmental Concern	Natural Resources	Urban Form
SCENARIO I	Business-taxpayer coalition. Policies emphasize economic growth through reduced controls on business centralization of governmental authority.	Cartels and economic warfare. Continuing political tensions.	Many markets increasingly dominated by a few giant corporations.	Little change. Some public service employment. Some job retraining programs.	Cautious enforcement of statutes. Some federal environmental repair programs.	Rapidly increasing prices level off by 1990 after successful development of substitution technologies.	Growth continues in suburbs with luxury development in city centers.
SCENARIO II	Consumer-taxpayer-conservationist coalition. Crackdown on big business and big government. Emphasis on competition and entrepreneurship. Strong state and local government.	Bilateral trade agreements break resource cartels. Favorable trade conditions. Relaxed tensions.	Large corporations closely controlled. Vigorous growth in small and medium-size companies.	Negative income tax replaces most other programs.	Strong control aimed particularly at large enterprises. Increased land use controls.	Moderately increasing prices level off by 1990 after successful development of substitution technologies.	Growth in medium-size cities and increased nucleation of metropolitan areas.
SCENARIO III	Government control is eclipsed by the dominance of conflicting interest groups. Government control strongly reasserted after 1990.	U.S. foreign influence diminishes. Increasing domestic influence of foreign companies.	Slow trend toward larger companies. Few new ventures in a risky economy.	Expansion and proliferation of programs. Much public service employment.	Some expansion of environmental regulations. Frequent litigation over environmental impacts of developments.	Stopgap policies, low prices prior to 1990. Severe energy crisis after 1990.	Increased land use densities in existing cities and suburbs. Little urban expansion.
SCENARIO IV	Minorities-equity-conservationist coalition. Strong government economic control to promote social welfare objectives. No-growth policy.	Strictly controlled foreign trade to promote social and economic policies. Relaxed tensions.	Large companies strictly controlled or nationalized. Resurgence of entrepreneurship after 1990.	Reorganization and significant expansion of social services.	Strict enforcement of existing statutes. Strict land use controls.	Closely managed R&D eliminates much reliance on petroleum by 1990's. High oil tax to discourage private use.	Growth in medium-size cities and increased nucleation of metropolitan areas.

Table 2

SUMMARY OF MAJOR QUANTITATIVE TRENDS

Component	Scenario I	Scenario II	Scenario III	Scenario IV
Population	medium	high	medium	high
GNP	very high	high	low	low
Personal Income	very high	high	low	low
Investment % of GNP	very high	high	medium	low
Consumption % of GNP	low	medium	high	medium
Govt. Expenditures % of GNP	low/ medium	medium/ low	medium	very high
Capital Consumption % of GNP	very high	high	medium	low
Interest Income % of GNP	high	very high	medium	low
Wages and Salaries % of GNP	low	low	medium	high
Profits % of GNP	very high	high	medium	low
Disposable Income % of Personal Income	medium	medium	high	low
Consumption Expenditures	high	high	medium	low
Transportation Expenditures % of Personal Expenditures	high	medium	medium/very high--1990s	low
R&D Expenditures % of GNP	high	very high	medium/high --1990s	low
Interest Rates	high	high	moderate	moderate
Money Supply	very high	medium	low	medium
Public Service Employment % of Total Employment	low	low	medium	very high
Service Employment % of Total Employment	high	very high	medium	medium
Price of Crude Oil	high	moderate	medium 1980s very high 1990s	high
Private Capital Formation	very high	high	low	low
Other Private Investment	high	high	low	medium

Table 3

SUMMARY OF MAJOR SCENARIO ECONOMIC INDICATORS

Scen-ario	Year	Population (millions)	Percent Labor Force Participation	Civilian Labor Force (millions)	Percent Employed	Civilian Employed (millions)	Average Annual Work Hours	Total Annual Work Hours (billions)	Productivity ($/hr)	GNP (billions
-	1970	205	41%	84	95%	79.7	1,967	157	4.5	720
I	1990	245	55	135	95	128	1,850	237	6.8	1,600
I	2000	262	50	131	95	124	1,850	230	8.3	1,900
II	1990	265	45	119	91	109	1,750	190	6.9	1,300
II	2000	300	45	135	91	123	1,600	197	8.1	1,600
III	1990	245	52	127	94	119	1,670	200	4.9	980
III	2000	262	55	144	94	135	1,670	226	4.9	1,100
IV	1990	265	48	127	95	121	1,740	210	4.4	920
IV	2000	300	48	144	95	137	1,740	238	4.4	1,050

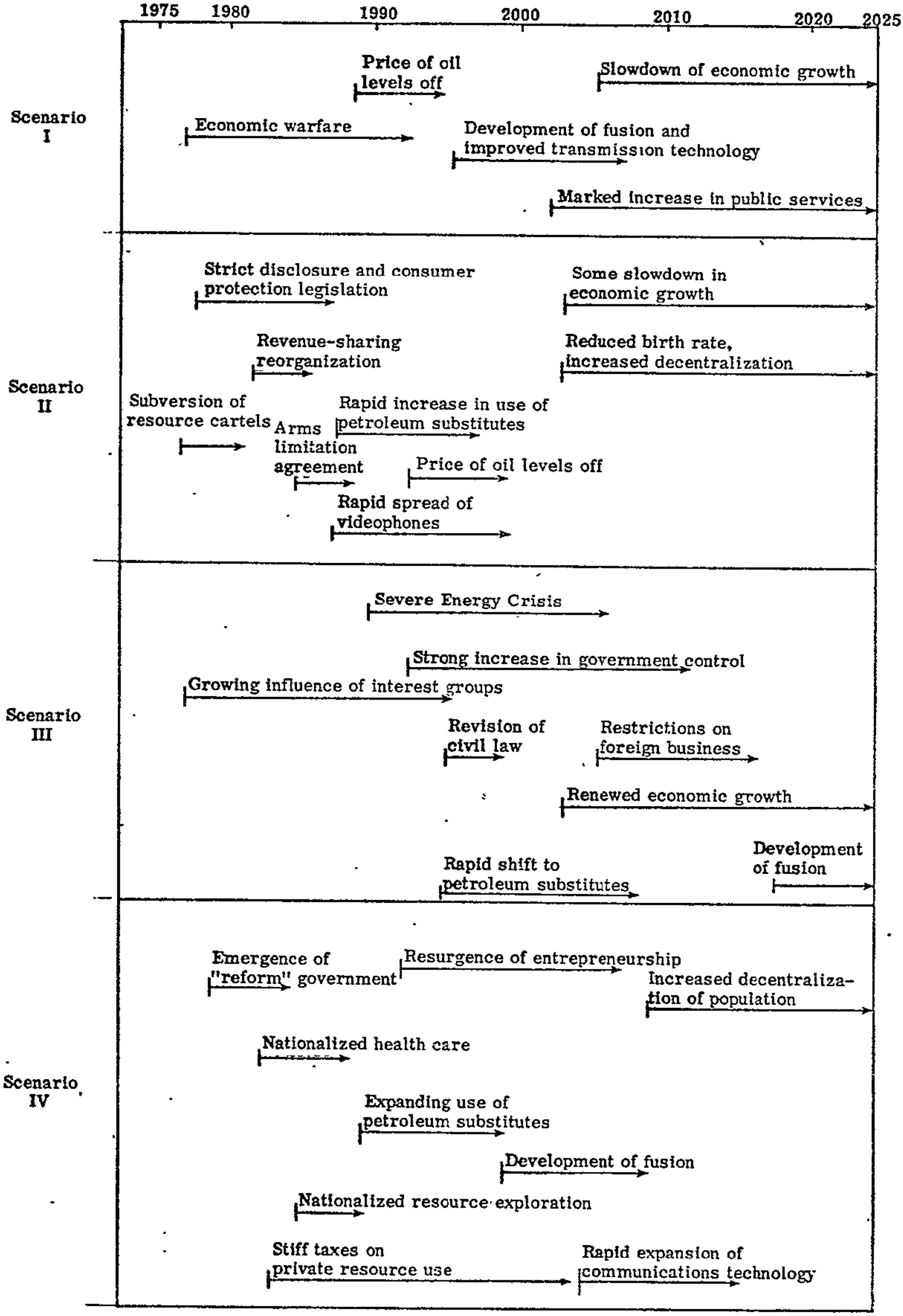

Figure 1. CHRONOLOGY OF IMPORTANT POLITICAL AND ECONOMIC EVENTS

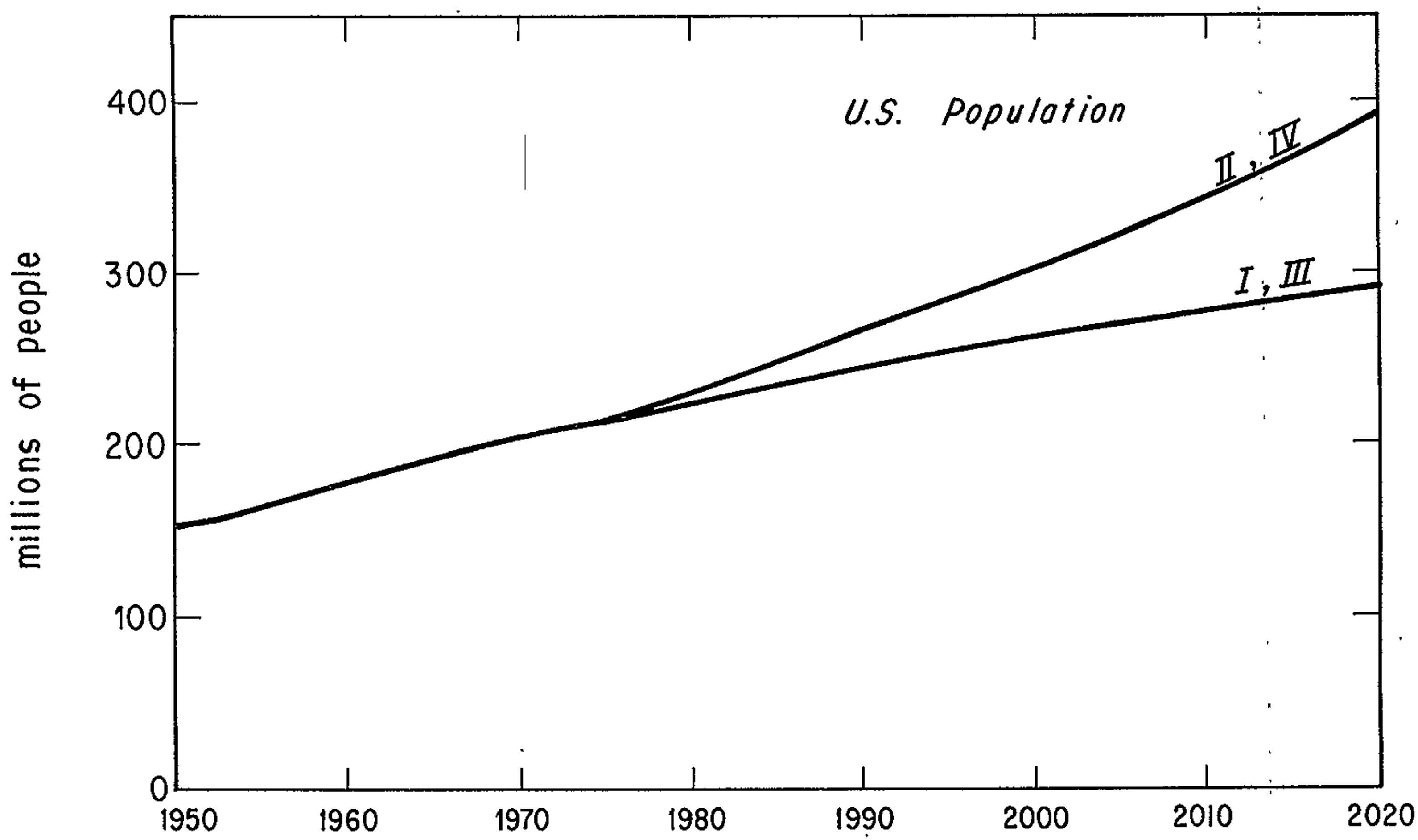

Figure 2. POPULATION TRENDS

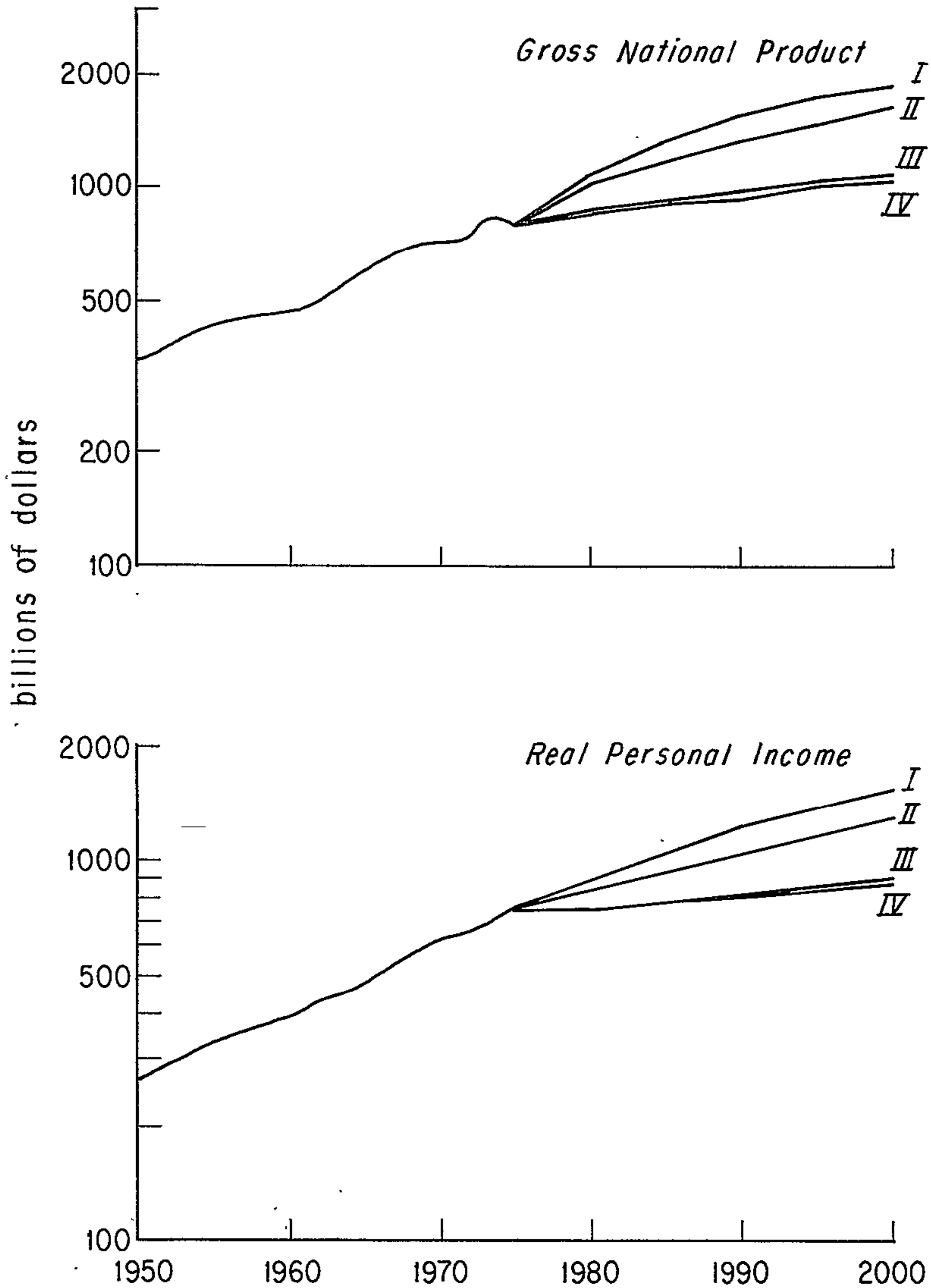

Figure 3. GROSS NATIONAL PRODUCT AND PERSONAL INCOME TRENDS

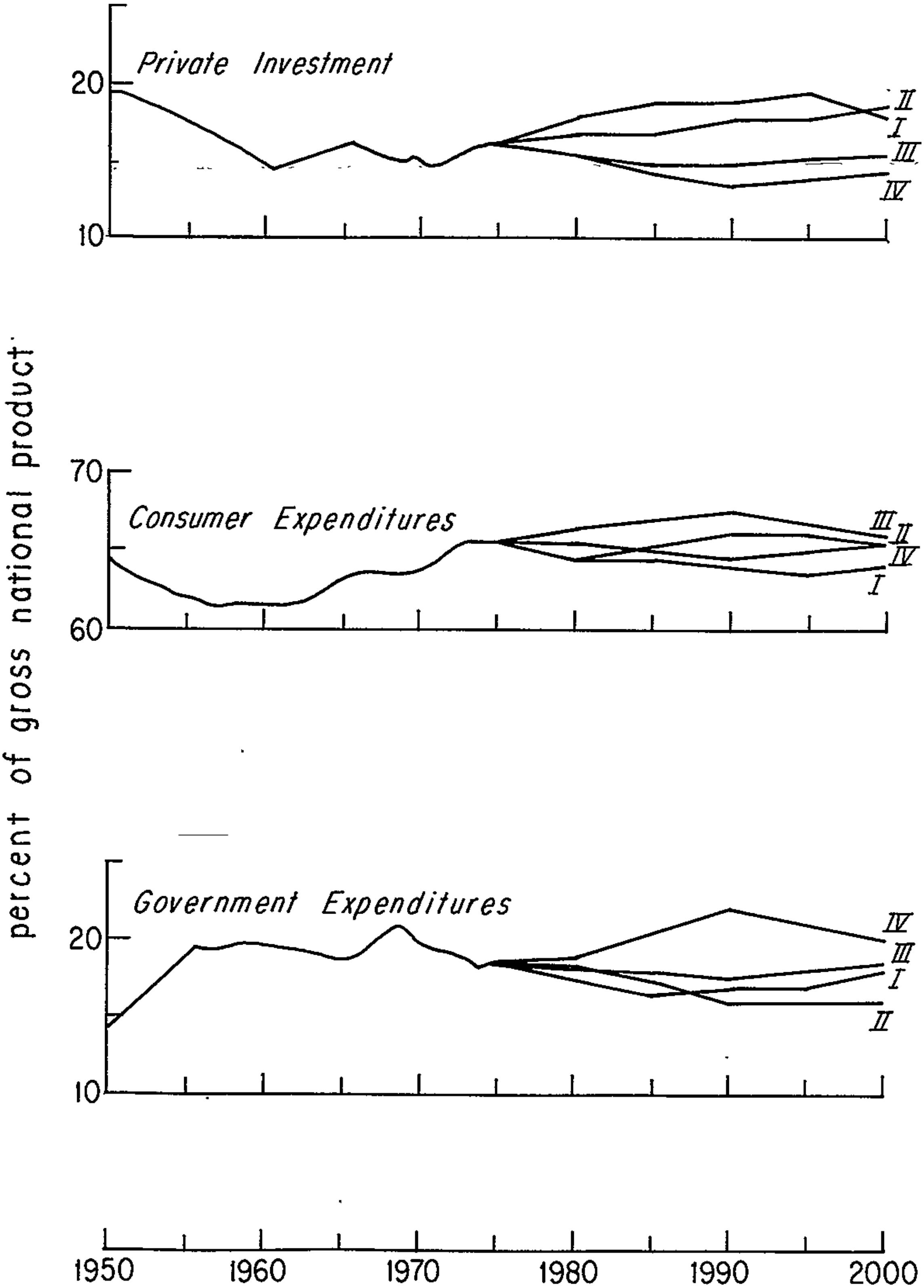

Figure 4. INVESTMENT AND EXPENDITURES

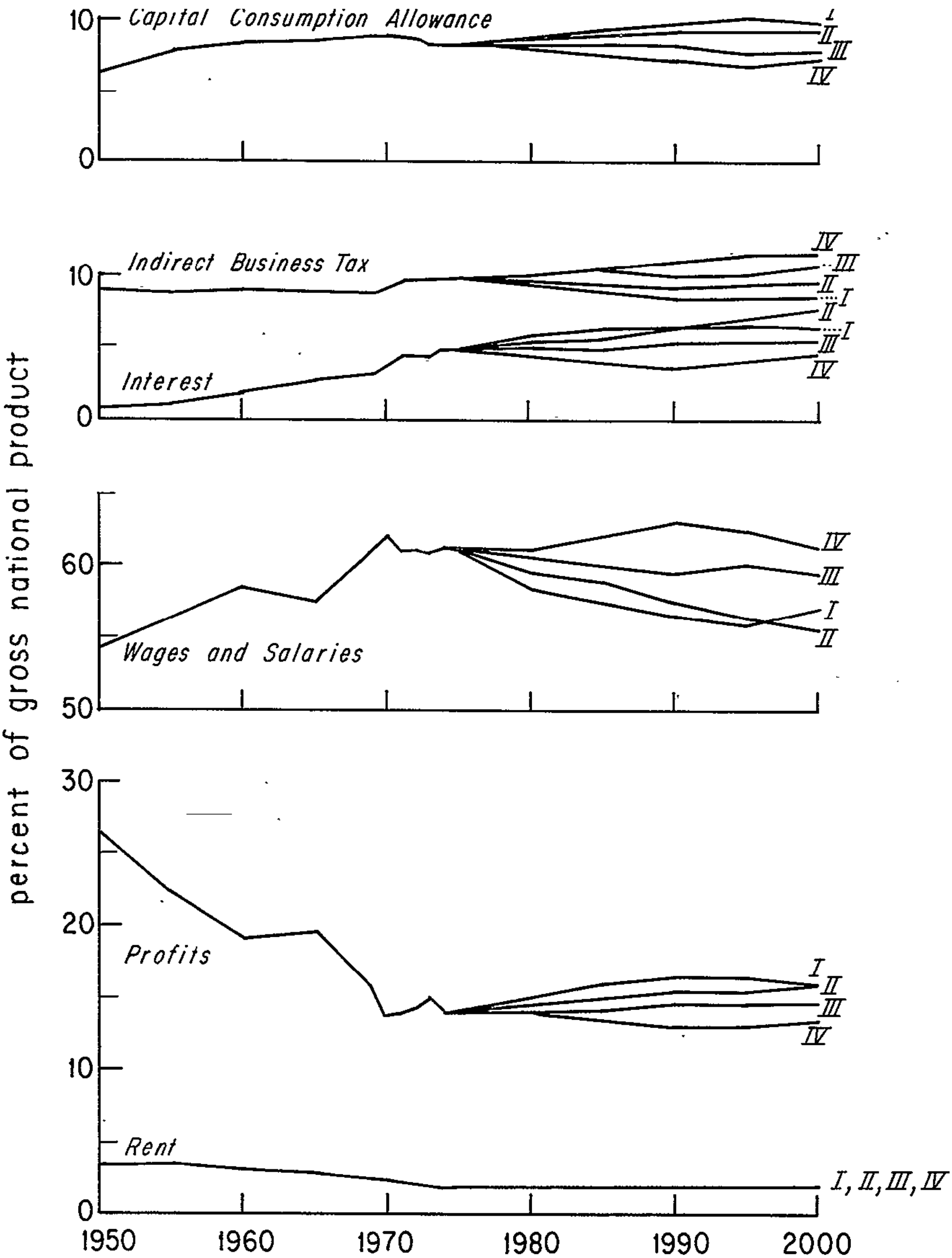

Figure 5. TAXES, WAGES AND PROFITS

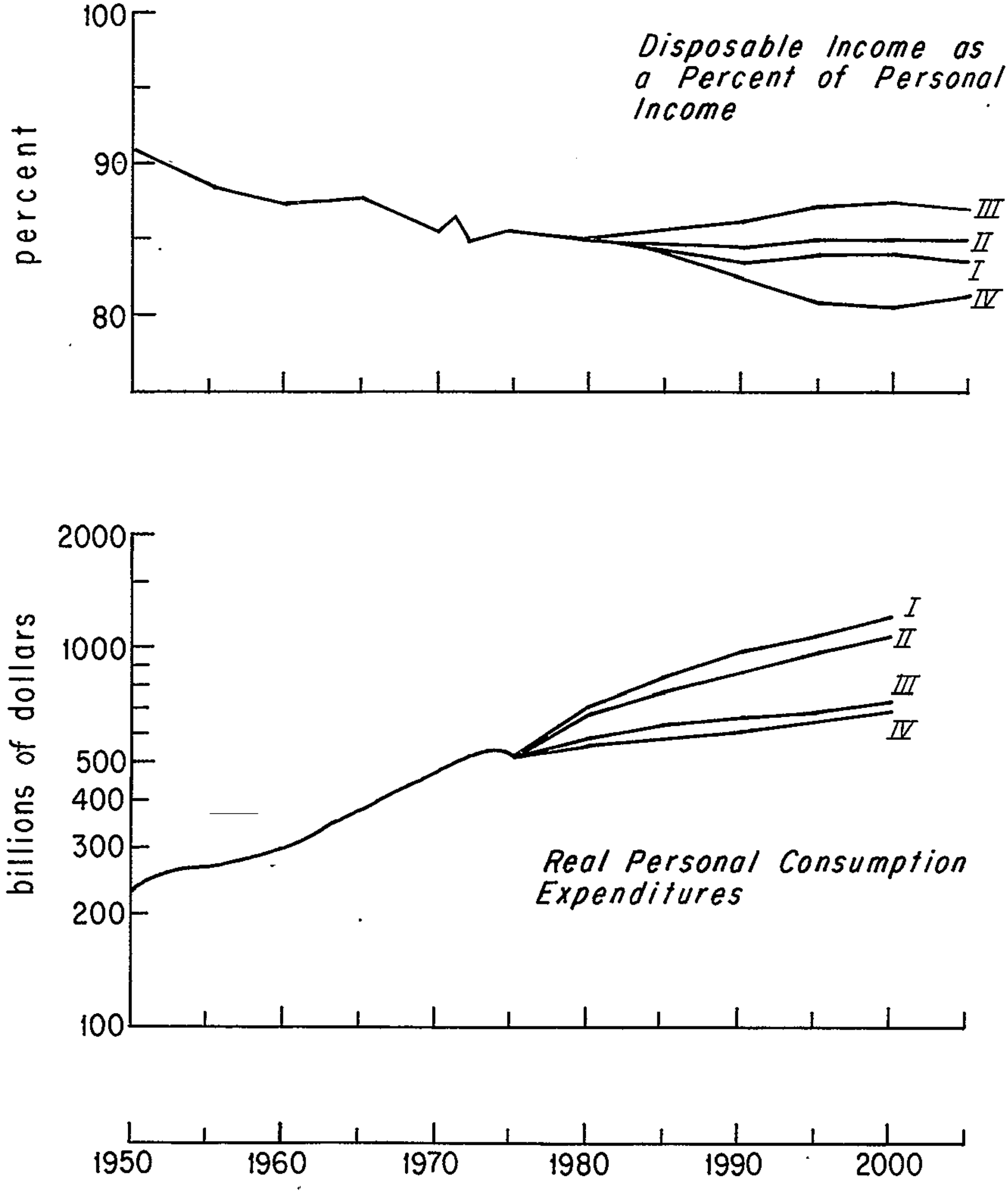

Figure 6. PERSONAL INCOME AND CONSUMPTION EXPENDITURES

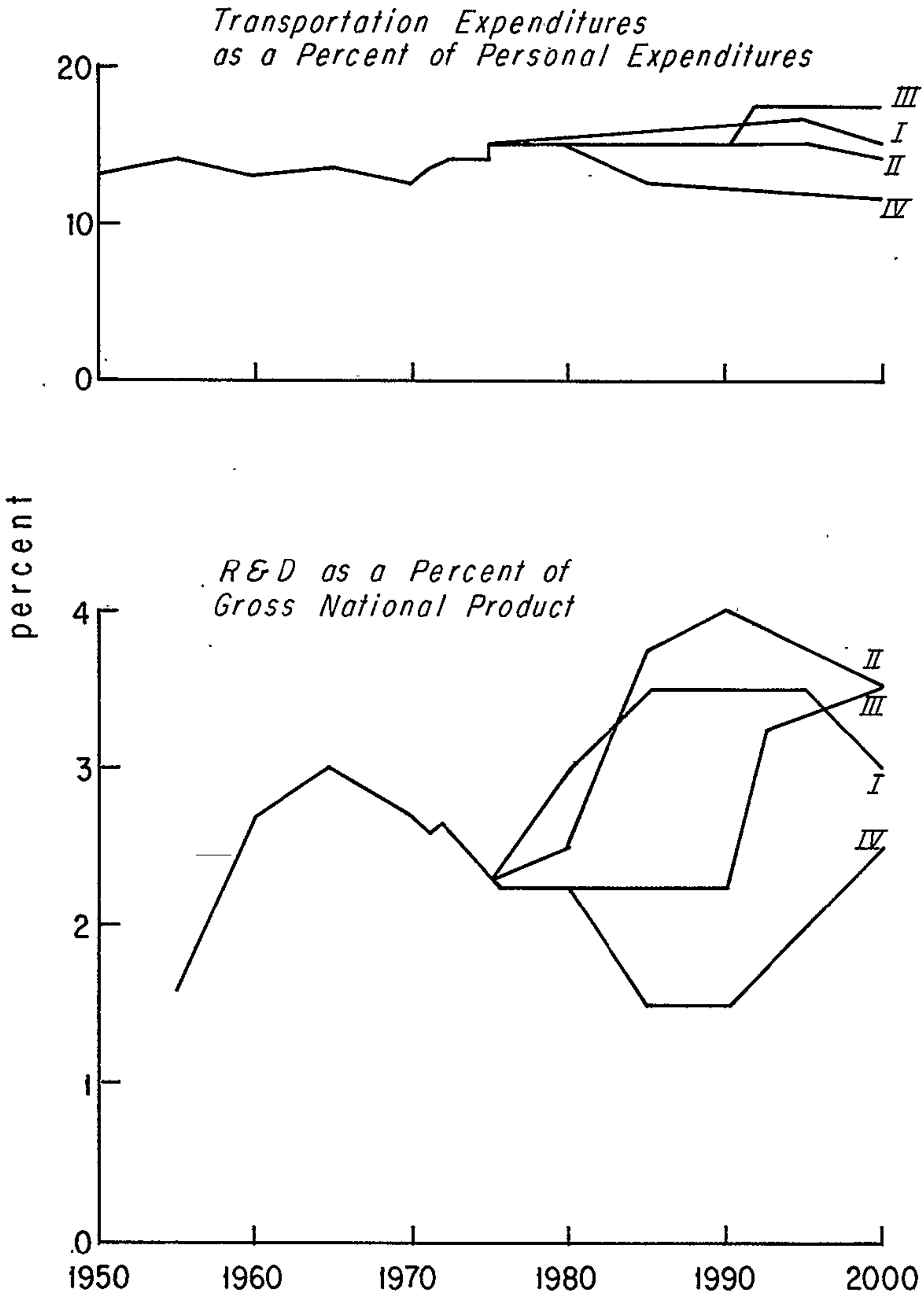

Figure 7. TRANSPORTATION EXPENDITURES/R&D EXPENDITURES

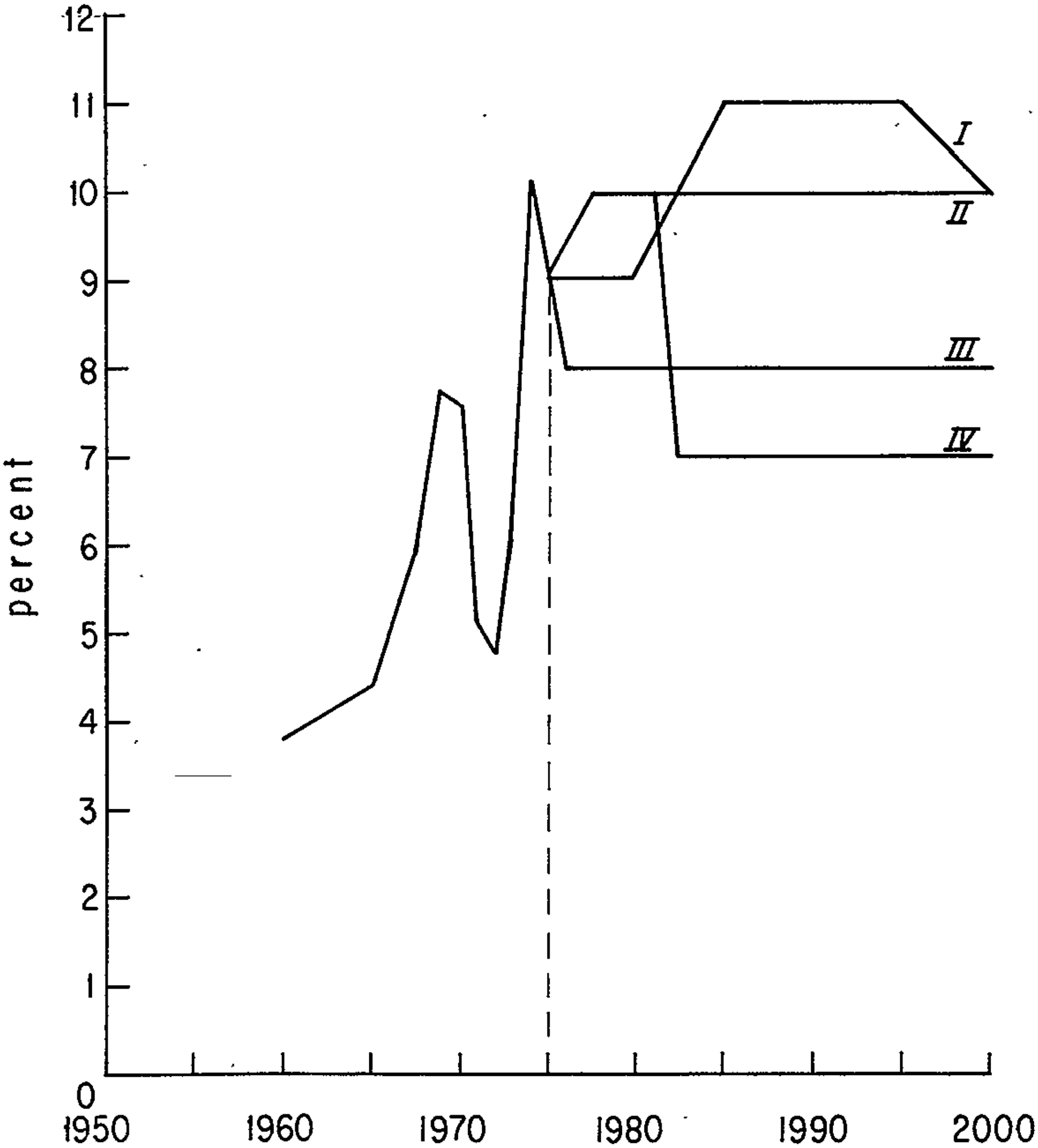

Figure 8. INTEREST RATES

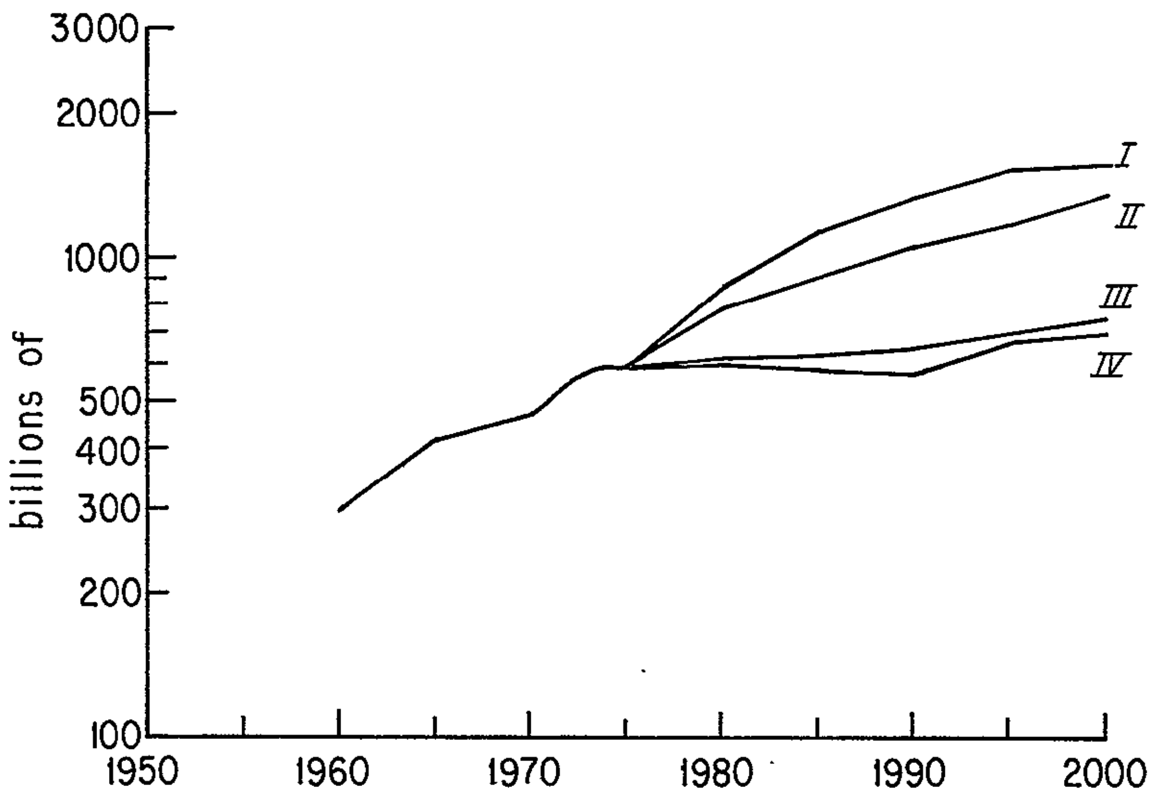

Figure 9. MONEY SUPPLY

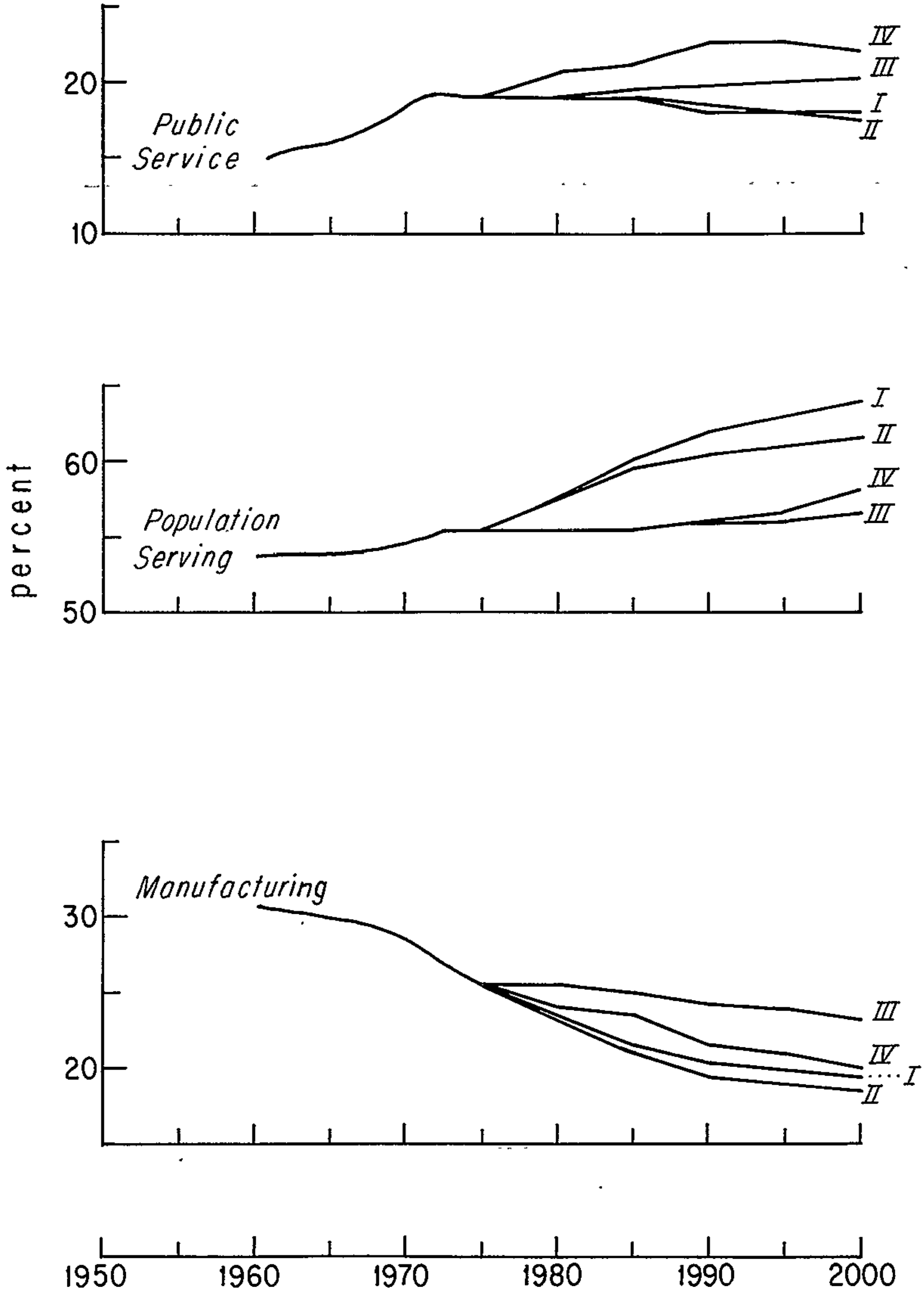

Figure 10. EMPLOYMENT

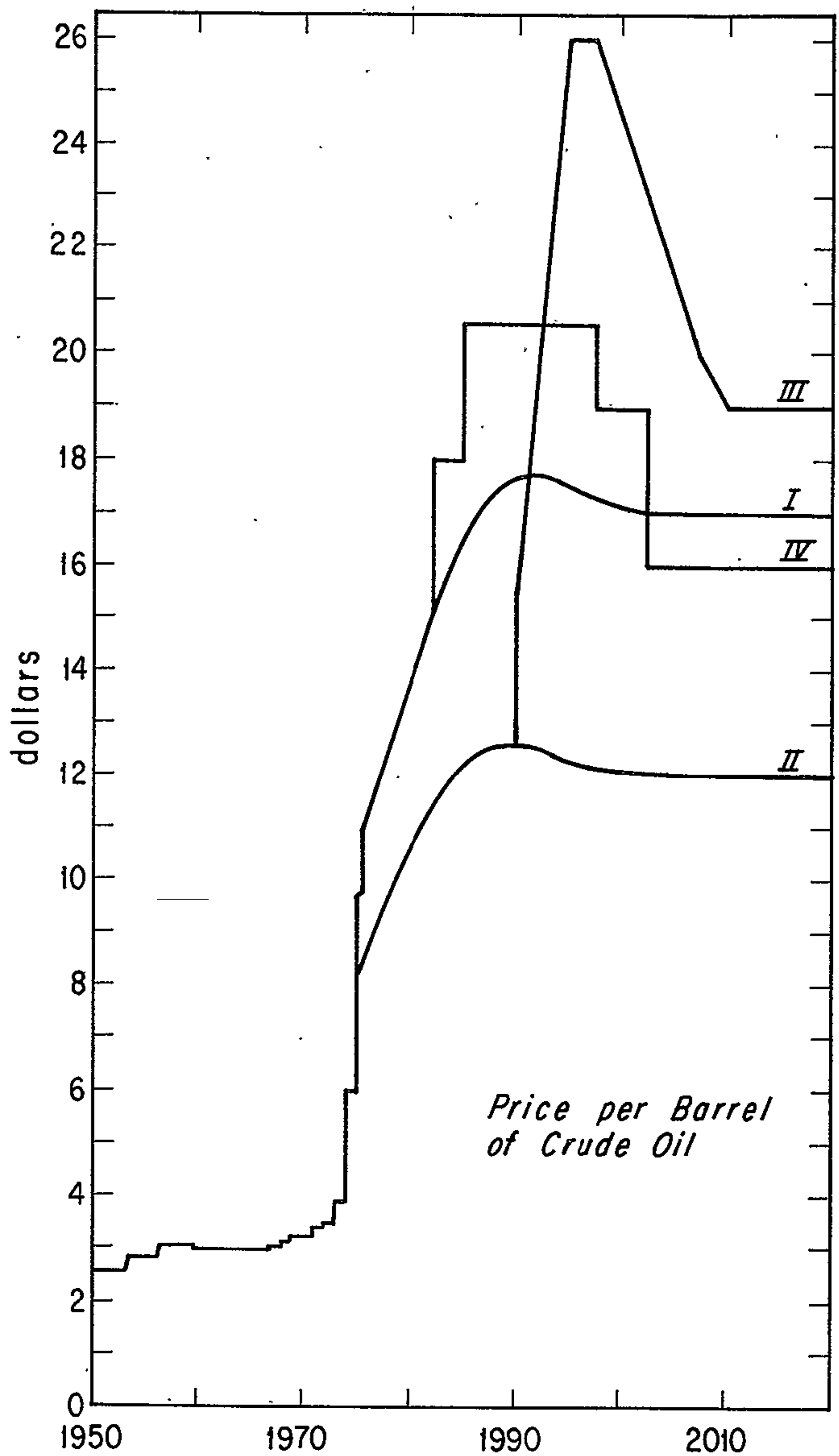

Figure 11. CRUDE OIL PRICES

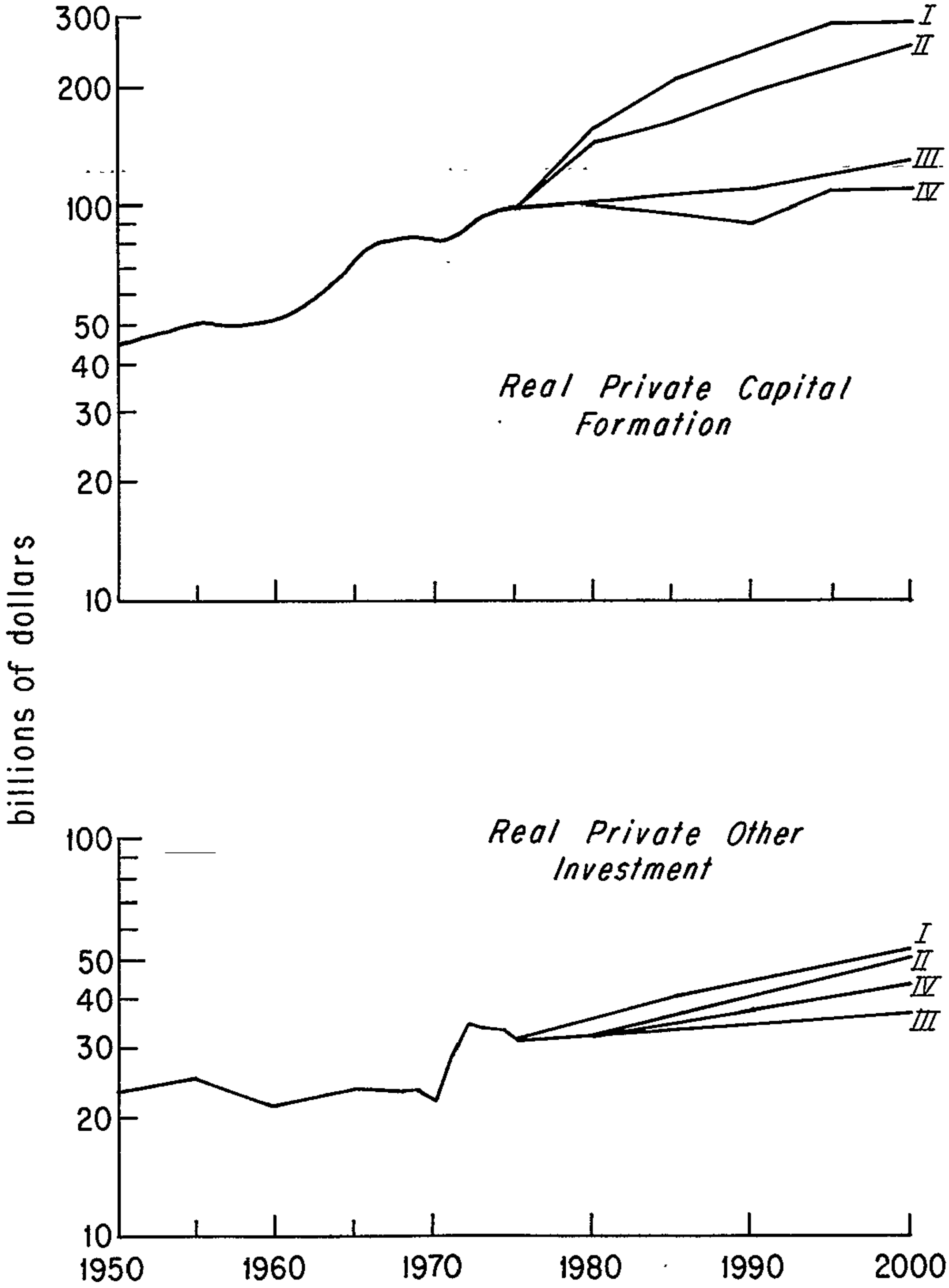

Figure 12. PRIVATE INVESTMENT COMPONENTS

Appendix A

CROSS-IMPACT ANALYSIS OF SCENARIO FEATURES

Appendix A

CROSS-IMPACT ANALYSIS OF SCENARIO FEATURES

A cross-impact analysis was undertaken early in the study to help reach decisions concerning:

- The selection of key scenario features whose variation would define the essential differences among scenarios and provide the basis for all other scenario features.

- The identification of interrelationships among scenario features that warrant particular attention in scenario development.

The cross-impact analysis provided valuable background assistance in conceptualizing and writing the scenarios. However, the scenarios themselves exhibit little of the formal structure of the cross-impact analysis. This is both because such a structure is unnecessary and even detrimental to understanding and using the scenarios as intended, and because once the cross-impact exercise had fulfilled its purpose of indicating what key features and interrelationships deserve special attention, this quantitative model was no longer used.

The major steps of the cross-impact analysis are the following:

1. Establish, by a multidisciplinary panel, a listing of candidate scenario features felt likely to be of major significance to future intercity transportation service and technology development.

2. Prepare a cross-impact matrix in which the rows and columns correspond to the candidate scenario features and in which each cell entry is a number representing the multidisciplinary panel members' judgments concerning how much each row feature directly influences the column feature.

3. Through adapted matrix arithmetic, derive a "total influence matrix" in which each cell entry is a number representing the influence of one scenario feature over another, both in the direct sense, as coded by the panel members, and in the indirect sense--for example, where feature "i" influences feature "j" because "i" influences "k" and "k" influences "j." Consideration of indirect influences was restricted to second-order (as in this example) and third-order effects only.

4. Accumulate the row and column sums of entries in the total influence matrix and compute their ratio. The scenario features for which these ratios are highest are generally

those which influence other features considerably but are themselves relatively uninfluenced by other features. Such features are candidates for selection as the basic features whose variations define the essential differences among scenarios.

5. Finally, examine the total influence matrix cells themselves. The high value entries suggest which interdependencies warrant systematic consideration in developing the full descriptions of the various scenarios.

Candidate Scenario Features

The analysis to refine a list of candidate scenario features involved considerable discussion and trial solutions. Ultimately, 26 different candidate scenario features were identified, as listed below. In this list, each feature is elaborated upon by listing a number of subsumed issues; the elaboration was kept in mind in subsequently developing the cross-impact cell entries.

1. Population Distributions
    a. Interregional population distribution
    b. Growth of population in different educational categories
    c. Population densities in intercity corridors
    d. Population age distribution
2. Employment Distributions
    a. Interregional employment distribution
        - Government (federal and state nonmilitary), professional, and administrative personnel
        - Military
        - Professional services (including higher education)
        - Basic (i.e., export) industries
    b. Interregional distribution of unionized workers
3. Personal Income
    a. Interregional distribution of personal income
    b. Trends in income distributions by region

4. Life Styles

   a. Family structure

      - Strength of immediate family ties
      - Strength and ICT implications of extended family ties over distances
      - Strength of persistence of long-term and new friendships over distance

   b. Leisure activities

      - Work week length
      - Vacation time (time available and scheduling patterns by income group)
      - Proportion of disposable income spent for recreation

   c. Trends in social value structure

5. Energy Resources

   a. Portable fuels

      - Import/domestic costs
      - Development of petroleum "stretching" methods (e.g., methane)
      - Development of synthetic fuels
      - Development of batteries

   b. Electricity

      - Generation economics
      - Location of generating capacity
      - Transmission economics

   c. Competing uses

      - Industrial requirements and efficiency
      - Household requirements and efficiency
      - Urban mobility requirements and efficiency

6. Land Resources

   a. Availability

      - Rural land in intercity corridors
      - Urban and urban fringe land for airports, etc.
      - Existing intercity rights-of-way and expansion potential

b. Use policy

- National land use policy
- Regional and state land use policies, especially in intercity corridors

7. Critical Materials Resources

8. Capital Resources

   a. Effects of interest rates and inflation on investment levels

   b. Capital availability and competition among major sectors of the economy (including transportation), between public and private uses

   c. Trends in the government budget distribution

   d. Capital availability and competition among transportation uses, between public and private, between new investment and maintenance and operating subsidy for the in-place systems

   e. Potential farebox revenues from ICT systems

9. Environmental Constraints

   a. Noise standards for ICT

   b. Air pollution standards for ICT

10. Urban Structure and Functional Changes

   a. Trends in central place hierarchy

   b. Development of major retirement communities

   c. Development of major domestic and foreign vacation centers

   d. Evolution of metropolitan area form, relative to transportation terminals and feeder networks

11. Air Service and Performance Characteristics (Truck, Local Service, Air Taxi, General Aviation Air Freight)

   a. Frequency, vehicle capacity, trip time (network effects), airport access time

   b. Aircraft costs

      - Fuel economy
      - Vehicle purchase cost
      - Labor productivity (for commercial avaition)

c. Environmental characteristics

- Noise characteristics
- Emissions characteristics

d. System capacity

- Spacing requirements (wing vortices)
- Terminal airspace
- Enroute airspace

12. Surface Mass Transportation Service and Performance Charactistics (Conventional Rail, High-Speed Rail, HSGT, VHSGT, Rail Freight, Pipelines, Waterways)

a. Frequency, trip time, terminal access time

b. Costs

- Fuel economy
- Vehicle purchase cost
- Labor productivity
- Land costs

c. Environmental characteristics

- Noise
- Air pollution emissions

d. System capacity (interference from other systems, e.g., between rail passengers and freight)

13. Highway Transportation Service and Performance Characteristics (Household Auto, Company Trucks, Common Carrier, General and Special Purpose Vehicle Rental)

a. Capacity and range

b. Costs

- Fuel economy
- Vehicle purchase or lease cost

c. Environmental characteristics

- Air polution emissions
- Noise characteristics

d. Highway capacity in intercity corridors

e. Implications of automated highways

14. Organization and Nature of Air Transportation Infrastructure Supply

    a. Commercial passenger airports

    b. General avaiation airports

    c. Exclusive air freight airports

15. Organization and Nature of Surface Public Transportation Infrastructure Supply

    a. Rail and terminals

    b. New guideways and terminals

    c. Pipelines, waterways, ports

16. Organization and Nature of ICT Highway Infrastructure Supply

17. Organization and Nature of Air Transportation Vehicle and Service Supply

    a. Commercial aircraft

    b. Airlines (trunk, local service, air taxis, air freight)

    c. General aviation aircraft

    d. Organization of expediting and intermodal transfers

18. Organization and Nature of Ground Mass Transportation Vehicle and Service Supply

    a. Rail and guideway vehicle manufacturing

    b. Shipbuilding

    c. Railroad passenger service organization

    d. High-speed ground transportation organization

    e. Rail freight service organization

    f. Pipeline service organization

    g. Water port organization

    h. Shipping service organization

    i. Organization of expediting intermodal transfers

19. Organization and Nature of Highway Vehicle and Service Supply

    a. Automobile, etc., manufacturing

    b. Truck manufacturing

    c. Personal vehicle rental company organization

    d. Intercity trucking company organization

    e. Organization of expediting and intermodal transfers

20. Air Transportation Regulation and Control

    a. Governmental control on commerical marketplace entry (trunk, local service, air taxi, air freight)

    b. Governmental control of vehicle certification

    c. Governmental control of commercial operations (routes, pricing, etc.)

    d. Control on operations by labor unions

    e. Control on operations and marketplace entry from industry organizations (e.g. IATA) and other sources

21. Surface Mass Transportation Regulation and Control

    a. Governmental control on marketplace entry

    b. Governmental control on operations

    c. Control from labor unions

    d. Control from other sources

22. Highway Transportation Regulation and Control (Especially on Trucking)

23. Electronic Communications Service Characteristics (Location and Diffusion)

    a. Personal communications (telephone, videophone, conference capabilities, etc.)

    b. Document transmission

    c. Bulk data transmission

24. International Politics and Trade Patterns

    a. Major import and export commodities (food, expert services, oil)

    b. International money flows and patterns of wealth

    c. Evolution of multinational corporations

    d. Coalitions of developing and/or industrialized nations and exercise of control over the world's wealth

    e. International political environment

    f. Stability of major international markets

25. Political Environment

    a. National priorities and impacts of various philosophies (growth vs no-growth, productivity vs equity, market competition vs central planning, GNP vs social welfare indicators of progress, market pricing vs welfare pricing)

- Political unity and strength of the user/equity constitutency (environmentalists, minorities, elderly, etc.)
- Unity and strength of organized labor
- Political unity and strength of businesses, cartels, etc.
- Political unity and strength of "idea merchants" (mass media, educational institutions, special study institutes)

b. Taxation policies

c. Political power distributions
   - Location of capital investment and subsidy authority (federal, state, regional, local)
   - Relative voting power of urban, suburban, and rural legislators and their relative tenure in office
   - Relative power of executive, legislature and judiciary

d. Location of control over environmental and natural resources
   - De-privatization of metal and energy industries
   - Evolution of mission-oriented government agencies (e.g., EPA, FEA)

26. Industrial Production

a. General aggregation and disaggregation trends in manufacturing

b. Broad structural changes in the economy, relative to the emerging postindustrial society
   - Productivity of various elements of the labor force
   - Labor force participation of various groups (women, minorities, elderly, youth)

c. Levels of R&D investment and implications for productivity
   - Corporate R&D investment, especially in transportation technologies
   - Government nonmilitary R&D investment, especially in transportation
   - Military R&D, especially in transportation

The Cross-Impact Analysis

The above 26 candidate scenario features were arrayed in matrix form, as illustrated in Table A-1.

Three study team members from diverse professional backgrounds were asked to fill in the matrix with values representing their estimates of how strongly each row feature directly affects each column feature. Specifically, the participants were asked to assign values with the following interpretations:

1.0--Strongest influence, implying that a change in the row feature causes an equivalent order-of-magnitude change in the column feature

0.8--Strong influence, but not as strong as above

0.6--Moderate influence

0.4--Weak influence

0.2--Very weak influence

0.1--Possibly some influence exists, but it barely exists, if at all

0.0--Nonexistent or insignificant influence, or the influence is undefined (i.e., a candidate feature's influence upon itself)

When the three matrices were filled in according to this scheme, to facilitate comparison, they were normalized to make the set of values in the three matrices have the same mean and standard deviation. Then, each matrix was subjected to the following mathematical manipulations to produce a total influence matrix that reflected all of the direct-, 2nd-, and 3rd-order influences:

Table A-1

CROSS-IMPACT MATRIX OF CANDIDATE SCENARIO FEATURES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1.POPULATION DIST.																										
2.EMPLOYMENT DIST.																										
3.PERSONAL INCOME																										
4.LIFE STYLES																										
5.ENERGY RESOURCES																										
6.LAND RESOURCES																										
7.MATERIALS RES.																										
8.CAPITAL RES.																										
9.ENVIRON. STNDRDS																										
10.URBAN STRUCTURE																										

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
11.AIR SERVICE CHAR																										
12.SURFACE SERVICE																										
13.HIGHWAY SERVICE																										
14.AIRPORT SUPPLY																										
15.RAIL ETC. SUPP.																										
16.HIGHWAY SUPPLY																										
17.AIR VEH. SUPPLY																										
18.MASS SURF.VEH.SP																										
19.AUTO/TRUCK SUPP.																										
20.AIR REGULATION																										

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
21.MASS SURF. REG																										
22.HGWY. REGULATION																										
23.COMMUNICATIONS																										
24.INT'L POL.&TRADE																										
25.POLITICAL ENVIR.																										
26.INDUSTRIAL PROD.																										

NOTE: The number of the columns correspond to the features spelled out in the rows.

For a matrix entry corresponding to row "i" and column "j", compute the cell value, Y_{ij}, of the total influence matrix as:

$$Y_{ij} = \max\left(X^1_{ij} \ , \ X^2_{ij} \ , \ X^3_{ij}\right) \quad \text{if } i \neq j \text{ , and}$$

$$Y_{ij} = 0.0 \quad \text{if} \quad i = j \ ;$$

where

X^1_{ij} is the cell value of the original matrix,

$$X^2_{ij} = \max_k \left(X^1_{ik} \cdot X^1_{kj}\right) \quad \text{for } i \neq j,\ X^2_{ij} = 0. \quad \text{for } i = j \ ,$$

$$X^3_{ij} = \max_{k\ell} \left(X^1_{ik} \cdot X^1_{k\ell} \cdot X^1_{\ell j}\right) \quad \text{for } i \neq j \ ,\ X^3_{ij} = 0, \text{ for } i = j,$$

max( ) is defined as the maximum value in the list,

$\max_{k(\ell)}$ is defined as the maximum value in the list, taken over all values of the subscript(s) k (and ℓ).

Note: This calculation method was chosen over simple matrix muliplication (to which it is analogous) in order to be able to interpret the results according to the original scale of values.

The next step was to sum the row entries and the column entries of the three total influence matrices and to compute their ratios. The results are listed in Table A-2. Candidate scenario features having high values of this ratio were considered for selection as the scenario features whose variations would define the essential differences among the scenarios.

As can be seen in Table A-2, there are numerous differences and similarities among the cross-impact analysis results for the three participants. The most striking insight obtained is that political environment was rated by all three participants as a feature that influences other features very strongly but is itself not dominated

Table A-2

RANKINGS OF INFLUENCE AND DEPENDENCE DETERMINED THROUGH CROSS-IMPACT ANALYSIS

Judgments of Participant #1

Feature	Row Sum (Influence)	Column Sum (Dependence)	Ratio (Infl./Dep.)	Ranking
1.POPULATION DIST.	17.26	16.80	1.03	
2.EMPLOYMENT DIST.	17.76	17.80	1.00	
3.PERSONAL INCOME	17.78	17.74	1.00	
4.LIFE STYLES	17.96	13.68	1.31	
5.ENERGY RESOURCES	22.03	16.99	1.30	
6.LAND RESOURCES	17.44	13.65	1.28	
7.MATERIALS RES.	16.27	16.68	.98	
8.CAPITAL RES.	22.08	16.83	1.31	
9.ENVIRON. STNDRDS	21.84	13.82	1.58	3
10.URBAN STRUCTURE	16.40	18.21	.90	
11.AIR SERVICE CHAR	11.50	19.91	.58	
12.SURFACE SERVICE	12.93	19.00	.68	
13.HIGHWAY SERVICE	16.78	17.17	.98	
14.AIRPORT SUPPLY	11.36	19.91	.57	
15.RAIL ETC. SUPP.	12.51	18.99	.66	
16.HIGHWAY SUPPLY	16.03	17.88	.90	
17.AIR VEH. SUPPLY	11.93	19.56	.61	
18.MASS SURF.VEH.SP	12.68	18.86	.67	
19.AUTO/TRUCK SUPP.	16.68	17.59	.95	
20.AIR REGULATION	11.02	14.18	.78	
21.MASS SURF. REG.	12.88	13.99	.92	
22.HGWY. REGULATION	16.91	12.51	1.35	
23.COMMUNICATIONS	10.52	12.17	.86	
24.INT'L POL.&TRADE	21.49	12.44	1.73	
25.POLITICAL ENVIR.	22.46	13.31	1.69	1
26.INDUSTRIAL PROD.	22.05	16.88	1.31	2

Table A-2 (cont.)
RANKINGS OF INFLUENCE AND DEPENDENCE DETERMINED THROUGH CROSS-IMPACT ANALYSIS

Judgments of Participant #2

Feature	Row Sum (Influence)	Column Sum (Dependence)	Ratio (Infl./Dep.)	Ranking
1.POPULATION DIST.	18.30	17.32	1.06	
2.EMPLOYMENT DIST.	20.44	17.75	1.15	
3.PERSONAL INCOME	19.57	16.79	1.17	
4.LIFE STYLES	19.25	18.21	1.06	
5.ENERGY RESOURCES	20.06	17.40	1.15	
6.LAND RESOURCES	15.85	16.00	.99	
7.MATERIALS RES.	17.49	17.21	1.02	
8.CAPITAL RES.	20.87	16.31	1.28	2
9.ENVIRON.STNDRDS	17.52	17.43	1.01	
10.URBAN STRUCTURE	14.65	18.50	.79	
11.AIR SERVICE CHAR	15.94	15.89	1.00	
12.SURFACE SERVICE	15.34	21.08	.73	
13.HIGHWAY SERVICE	19.72	16.53	1.19	
14.AIRPORT SUPPLY	14.22	18.61	.76	
15.RAIL ETC. SUPP.	15.98	21.23	.75	
16.HIGHWAY SUPPLY	18.96	17.38	1.09	
17.AIR VEH. SUPPLY	15.86	16.24	.98	
18.MASS SURF.VEH.SP	15.34	21.33	.72	
19.AUTO/TRUCK SUPP.	18.79	17.40	1.08	
20.AIR REGULATION	13.59	17.22	.79	
21.MASS SURF. REG.	13.24	19.26	.69	
22.HGWY. REGULATION	17.23	16.93	1.02	
23.COMMUNICATIONS	17.28	14.46	1.19	
24.INT'L POL.&TRADE	19.61	17.47	1.12	
25.POLITICAL ENVIR.	21.05	16.24	1.30	1
26.INDUSTRIAL PROD.	20.54	16.48	1.25	3

Table A-2 (cont.)
RANKINGS OF INFLUENCE AND DEPENDENCE DETERMINED
THROUGH CROSS-IMPACT ANALYSIS

Judgments of Participant #3

Feature	Row Sum (Influence)	Column Sum (Dependence)	Ratio (Infl./Dep.)	Ranking
1.POPULATION DIST.	14.91	14.42	1.03	
2.EMPLOYMENT DIST.	13.64	14.68	.93	
3.PERSONAL INCOME	14.75	13.14	1.12	
4.LIFE STYLES	13.09	12.43	1.05	
5.ENERGY RESOURCES	15.92	13.74	1.16	
6.LAND RESOURCES	14.77	13.63	1.08	
7.MATERIALS RES.	12.26	11.12	1.10	
8.CAPITAL RES.	15.56	14.62	1.06	
9.ENVIRON. STNDRDS	14.32	14.51	.99	
10.URBAN STRUCTURE	15.12	15.35	.98	
11.AIR SERVICE CHAR	12.18	14.30	.85	
12.SURFACE SERVICE	12.63	15.30	.83	
13.HIGHWAY SERVICE	14.97	15.19	.99	
14.AIRPORT SUPPLY	12.72	14.08	.90	
15.RAIL ETC. SUPP.	12.70	15.47	.82	
16.HIGHWAY SUPPLY	14.37	15.37	.93	
17.AIR VEH. SUPPLY	11.27	15.15	.74	
18.MASS SURF.VEH.SP	11.34	14.24	.80	
19.AUTO/TRUCK SUPP.	13.89	13.76	1.01	
20.AIR REGULATION	11.93	11.64	1.02	
21.MASS SURF. REG.	11.91	12.54	.95	
22.HGWY. REGULATION	13.40	13.00	1.03	
23.COMMUNICATIONS	12.37	9.26	1.34	2
24.INT'L POL.&TRADE	13.55	10.05	1.35	1
25.POLITICAL ENVIR.	16.13	12.65	1.28	3
26.INDUSTRIAL PROD.	14.84	14.88	1.00	

by other features, thus having the attributes that would cause it to be a desirable feature upon which to hang scenario definitions. International conditions also displays such attributes. As a result, it was decided to search for scenario definitions based upon significant variations in these two key features, and to develop all other scenario features in a manner consistent with these.

The nature of the significant variations in these two key scenario features, which set the tone for the overall scenarios, are evident in the scenario summaries, which appear in the body of this report. These variations were defined by means of a series of discussions aimed at achieving widely different implications for the evolution of intercity transportation. As a result of these discussions, it was decided that sufficient variation could be achieved with the four scenarios described.

The results of the cross-impact analysis were also used to highlight the interrelationships among scenario features that warranted systematic consideration in developing full scenario descriptions. Toward this end, the matrices of total interactions were examined to find the largest entries. The nature of the influences represented by these high value cell entries was puzzled over, and this analysis contributed insights that led to certain characteristics of the scenarios. While this final step was highly subjective, the availability of the cross-impact analysis results is felt to have contributed significantly to the outcome.

PART B

DESCRIPTION OF TRANSPORTATION SCENARIOS

by

Dan G. Haney
Peat, Marwick, Mitchell & Co.

PART B

DESCRIPTION OF TRANSPORTATION SCENARIOS

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I. INTRODUCTION

This report is one of a series designed to assist in identifying and evaluating future intercity transportation system impacts. It presents a number of qualitative descriptions of intercity transportation systems that might be in operation in the year 2000. It also describes a series of postulated future events that rationalize how the year 2000 systems evolved from those in operation today.

Recognizing that the future is unpredictable, four descriptions are presented; each one is called a "transportation scenario." Each is developed by considering an associated "background scenario" describing alternative futures for national and international conditions that would impact on intercity transportation. The background scenarios are described in Part A of this volume, entitled *Background Scenarios of Possible Future States of Society*. The reader is encouraged to review that material before considering the systems described here.

The transportation systems are intended to present examples, not necessarily the most-likely developments, because just as one can imagine many background scenarios regarding what will happen to the nation by 2000, one can imagine many transportation system permutations consistent with a given background scenario. While the transportation systems selected for inclusion within each of the scenarios are considered plausible--given the background scenario--it is acknowledged that a certain degree of arbitrary judgment has been applied to develop the transportation scenarios; in some cases, the characteristics of the transportation system are such that it really does not make any difference which scenario the system is applied to.

The transportation scenarios are, however, constructed within the same rationale as were the background scenarios--to display a number of alternative futures that differ substantially from one another. Such an approach permits realistic consideration of various actions or decisions even though the real future is uncertain. The objective is to determine whether desirable actions vary from one future to another. If the same action is indicated for all futures, one can proceed with great confidence, whereas if desirable actions differ greatly with alternative futures, judgment of the future becomes critical.

A substantial amount of imagination has been applied in developing the descriptions of transportation scenarios contained in the following chapters. The assumed systems are generally based on the descriptions of Volume 3, entitled *Technological Characteristics of Future Intercity Transportation Modes*, but in some cases more advanced characteristics are postulated. In these cases, it is hoped that tests of plausibility will be passed. The purpose in such extrapolations is to permit relatively wide-ranging views of the future twenty-five years from now, yet taking into account the substantial amounts of time that are required

to implement a new technology, especially one requiring new infrastructures. It attempts to recognize the difficulties that have continually encumbered technological forecasters who are concerned with the challenge of producing something that is technically, operationally, and economically successful in the near term.

Analysis Design

In addition to describing future transportation systems in general terms, this report establishes the design for a quantitative analysis of the transportation scenarios. The design considers travel settings and reference cases (or baseline conditions) against which the impact of transportation scenarios can be measured. Geographic settings and reference cases are described below; specific transportation system performance assumptions and analysis results are contained in Part C of this volume.

Travel Settings. The following travel corridors and city-pair travel markets were selected as case examples of the travel settings in which the hypothesized transportation scenario innovations might occur:

High Density Travel Corridors

- Boston-Washington
- Chicago-St. Louis
- Portland-Seattle

Large City-Pair Markets

- Los Angeles-Washington
- Boston-Denver
- Los Angeles-Dallas/Fort Worth
- Atlanta-Detroit

Smaller and/or Shorter Distance City-Pair Markets

- Kansas City-Oklahoma City
- Stockton-Fresno
- Denver-Billings
- Detroit-Traverse City, Michigan

The case study approach to travel settings introduces a degree of realism to the application of technologies in terms of volumes of travel and trip distances. However, the reader is cautioned to view the selected travel settings as case examples within the context of the potentially more widespread introduction of new technologies.

Reference Cases. To provide a basis for measuring impacts of the transportation systems postulated in a given scenario, a set of four reference cases is also postulated--one reference case for each background/transportation scenario. The common feature among the four reference cases is that each assumes the same transportation technology for the year 2000. For all modes, only nominal improvements, if any, are postulated relative to today's systems (e.g., somewhat larger vehicles and higher passenger load factors for public modes, marginally improved fuel efficiency for automobiles). The features that cause the reference cases to differ from one another are the background scenario conditions associated with each: population, income, wage rates, cost of capital, and price of fuel.*

The background scenario conditions for each transportation scenario and its respective reference case are "constant"; this provides the basis for comparing the two in terms of the "variables"--transportation innovations. Whenever a term such as "higher" or "lower" is used in a transportation scenario, it means the factor is higher or lower than in the reference case. Because of variations in both transportation innovations and background conditions, *comparisons cannot be readily drawn between transportation scenarios.*

Summary of Technology Assumptions

Table 1 presents a summary of the transportation technology and service assumptions that are postulated in the study's transportation scenarios. Overall, a variety of innovations are assumed. While it might be argued that even more diversity is possible within or among transportation scenarios, the selected design is judged sufficient for purposes of impact identification and evaluation.

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*Statements regarding costs in this report and most future cost data presented in other study reports are in terms of constant dollars.

Table 1

TECHNOLOGIES AND SERVICE CHANGES EMPHASIZED IN TRANSPORTATION SCENARIOS

Mode	Included in Transportation Scenario(s)	Remarks
Air System		
Conventional aircraft (CTOL)		
– With improved cost or speed characteristics	I, II, IV	Improvements vary among scenarios
– Degraded performance (cost or frequency)	III, IV	
900-passenger aircraft	I	
SST	I	
Short runway aircraft	II	
Small aircraft, short-haul services	II, IV	
Air traffic control improvements	I, IV	
Rail/Fixed Guideway		
AMTRAK Service		
– Improved	III, IV	Both improvements and discontinuances assumed in IV
– Curtailed	I, II, IV	
Improved (high-speed) passenger trains	I, II, III	
Tracked Levitated Vehicle Systems	IV	
Bus		
Improved service (cost/speed/comfort)	I, II, III, IV	Nature and extent of improvement varies among scenarios
Small vans	II	
Auto		
Improved fuel consumption efficiency	II, III, IV	Degrees of improvement varies by scenario
Higher speed service	I	
Electric-powered	I	

II. TRANSPORTATION SCENARIO I

Introduction

Transportation Scenario I takes place within Background Scenario I, which is characterized by national emphasis on economic growth; encouragement of business, especially big business; government cooperation with business; and considerable research and technology advances that are placed in service on a large scale mostly by private industry.

Transportation Policies and Systems

The intercity transportation systems in operation in the year 2000 emphasize service between large cities and utilize considerable new technology that has been made possible through vigorous research and development programs in the 1980s and 1990s.

Many of the transportation systems are operated by large corporations that are strongly oriented to serving profitable markets and minimizing service to smaller, marginal markets. Advanced air, auto, and bus technology is utilized. The modes that are prevalent are those that provide the most attractive private financial returns.

Federal policies in transportation are mainly oriented to supporting large corporate interests, with emphasis on economic growth and centralization of economic activity. Private interests have succeeded in specializing intercity transportation services without major federal policy involvement or federal legislation. Multimodal conglomerates are formed and are successful in integrating and rationalizing intercity freight and passenger transportation. State and local governments are not involved to a major extent in new intercity transportation programs.

The federal government and large corporations have struck a strong partnership in research and technology programs. Large programs of system development, such as the supersonic transport (SST) program, are heavily funded by the federal government but are managed and carried out almost entirely by industry. Smaller programs are funded by private industry without large amounts of government funds; these are typically ones having relatively low risk.

In general, economic regulatory controls on transportation are relaxed. Both the Civil Aeronautics Board (CAB) and the Interstate Commerce Commission (ICC), as a result of legislative actions and executive pressures, have encouraged mergers of airlines and of railroads and have relaxed controls regarding service to small communities and levels of competition in larger markets. Fares and rates are based mostly on what the market will bear, but both agencies permit experimentation in setting fares, an action that produces price-cutting in some markets, which in turn results in some marginal operators leaving the field. Other policies of the

agencies result in carriers evolving toward concentrating service in large markets, within a "controlled oligopolistic" environment.

The individual modes that are in service in the year 2000 are described in the following paragraphs.

Air Transportation. Two major technological programs have been completed by the year 2000: the advanced supersonic transport (SST) and the giant-jet.

The SST program, funded by the federal government but carried out by a conglomerate formed especially for the effort, was made possible by intense, successful research by federal agencies and interested companies that has overcome the sonic boom and upper atmosphere ozone layer problems. New techniques of propulsion enable development of a vehicle having reasonable fuel consumption characteristics. SSTs are in operation on transcontinental routes as well as on transocean routes. Substantial numbers of SSTs are being sold to foreign nations.

The giant-jet program, which was generated largely by carriers' route structure streamlining efforts and reduced competition, resulted in a 900-seat aircraft having seat-mile costs somewhat lower than projected for such aircraft in the mid-1970s. This came about by advances in both propulsion and aerodynamics which were completed under federally sponsored research and technology programs in the 1980s. Giant-jet service operates on several major traffic routes in the U.S. as well as overseas. The large aircraft are increasingly used by charter operators who operate them in an 1,100-seat configuration, enabling especially low fares.

The above advances were also applied to smaller aircraft designs. By 2000, an advanced twin-jet, 180-seat widebody aircraft is in operation as are somewhat larger replacements (or derivatives) for a range of aircraft sizes such as the DC-9, 727, DC-10/L-1011, and 747. Each of these have lower seat-mile costs than earlier conventional takeoff and landing aircraft (CTOLs). The passenger versions of these operate at a Mach 0.92 speed using transonic airfoils.

Large aircraft in passenger service are also heavily used for air freight movement, utilizing the substantial belly capacity. Air freight continues to grow rapidly in volume, but is still a small percent of total intercity freight ton-miles.

In line with other profit-maximization moves, a number of the carriers adopt policies to reduce indirect costs. Relaxed regulatory policies permit low-cost service to be provided in dense markets that goes beyond that provided by Pacific Southwest Airlines (PSA) in California during the 1970s; it includes no-reservation service, no interline ticketing, instant-payment sales, no travel agent involvement, coach-only seating, and no-frills service.

A controversial CAB decision permits the certificated carriers to discontinue service in marginal markets, leaving them without air transportation. With these actions, cross-market subsidization is no longer an issue to the airlines. Short-haul service is continued by the carriers in profitable markets.

The increased economic growth in the nation produces substantial increases in general aviation activity both in the business and recreational sectors. Improvements in general aviation aircraft fuel consumption make them increasingly attractive for intercity travel over short to moderate distances.

The centralization of air routes and the concentration of air service to large cities, together with other factors that have caused the air demand to grow, create significant needs for airport construction in the larger cities. By 2000, new airports are built in New York, Chicago, Los Angeles, Miami, St. Louis, and Cleveland. Airport capacity in other cities is increased by airfield and landside expansion projects.

The requirements for air traffic control system improvements are substantial. The upward evolution of the average number of seats in air carrier aircraft, which tends to reduce the number of aircraft movements, is totally overshadowed by the increase in general aviation movements. Several important improvements in air traffic control capability are made, beyond the Upgraded Third Generation System, which was implemented by 1990. More direct aircraft routing and lower levels of congestion and delays made possible by the system in operation in the year 2000 results in some reductions in air travel times--on the order of 4% compared with 1974 travel times. The big impact of these improvements is in terms of capacity and safety.

Rail Transportation. Among the more visible attainments of the corporate-government partnership is the emergence of a reorganized national rail network. Government policy actions permit the corporate powers to integrate service into a small number of new transportation companies. To improve profits, freight service is substantially cut back on small markets, and many branch lines are abandoned. The rail network becomes one of heavy trunk-line concentration; the reduced number of commodities that are carried are those most suited to rail service, with trucking providing more diversified freight transport. Rail freight traffic increases.

Because the private railroads totally focus on improving profits in hauling freight, pressure increases to eliminate rail passenger service where not needed. AMTRAK as an organization continues as in 1975, but private corporate pressures result in discontinuance of passenger service on certain low-volume lines. The cost savings due to the discontinuance of service on these lines frees funds to permit improvement of service on the remaining lines.

Improved passenger train (IPT) service is installed by AMTRAK in high volume corridors, providing significantly improved line-haul speeds of up to 150 miles per hour (241 kilometers per hour).

Bus Systems. Bus vehicles, in terms of service to the traveler, are much like those of earlier decades; however, the bus vehicle improves its fuel-consumption advantage over the other modes by improved power plant and transmission designs. As in the case of automobiles (see following), buses operate under a 70 miles-per-hour (113 kilometers per hour) speed limit. The higher speed, compared with the mid-1970s, contributes to lower overall operating costs. Because of intermodal competitive arrangements, however, bus carriers do not reduce fares. Instead, the lower costs produce higher profits.

Bus service to many cities remains as in earlier years; however, in reaction to discontinuance of air and rail passenger service to some smaller cities, bus subsidiaries improve service and enjoy increased patronage in those locations, even though they do not reduce fares.

Auto Systems. Through the 1980s and 1990s, the U.S. auto industry improves its competitive performance against foreign manufacturers, as a result of technical advances. These include the development of a turbine engine using advanced ceramic technology.

Because of the fuel economies and aerodynamic improvements that have been achieved, a 70-mile-per-hour speed (113 kilometers per hour) is in effect.

Motivated by the national policy to conserve petroleum, experimentation in electric vehicles has also increased. Advanced battery technology breakthroughs of the late 1980s make the electric auto a viable mode of transportation (with good acceleration) over ranges of 100 miles (160 kilometers). Even in hilly cities, many families now own an electric vehicle for in-town use.

A Federal Highway Administration (FHWA) and Urban Mass Transportation Administration (UMTA) program, conducted in close cooperation with the automobile industry, demonstrated in 1992 the feasibility of a noncontact induction power pickup system that could be used to provide an off-vehicle power source for the electric auto. The system also provides lateral guidance, and with a low-cost radar/computer device, automatic collision avoidance. The FHWA/UMTA program perfected techniques to install the transmission lines in existing highways at a cost of $250,000 per lane-mile ($155,000 per lane-kilometer). This suggests a user charge for the small auto of not more than 1.0 cent per vehicle-mile (0.62 cents per vehicle-kilometer) for the transmission system.

By the year 2000, three large demonstration programs are in operation in areas in which nuclear breeder reactors have been installed to provide low-cost electricity. The demonstration programs are designed to

noncontact guided electric auto. A traveler in cities where the demonstration program is in operation can have his electric vehicle equipped with a pickup system at a reasonable charge, which also includes a pro rata fee for the guideway installation. To preclude fraudulent use of the system, special vehicle licenses are provided for equipped vehicles, and highway police monitor highways for unauthorized vehicles. Authorized vehicles are equipped with a power consumption meter that is read by a device in licensed service stations that automatically transmits the reading to the vehicle's billing office. Using off-vehicle power is considerably cheaper than the on-board advanced batteries.

The demonstration programs at the three cities provide electric highways on major freeways within the urban area as well as on interstate freeways serving major-volume routes to other nearby cities.* The economic attractiveness of the urban installations appears high; the attractiveness of intercity installations is unresolved.

Access/Egress Systems. Because of the successes in technological achievements of the private auto, public transit systems other than bus systems were not widely installed through the 1980s and 1990s. Notable among the number of exceptions is the Denver automatic transit system, which provides areawide service and has a connection to Stapleton International Airport.

In most cities, however, the major program affecting access and egress to and from intercity passenger terminals is the highway program. Capacity improvements were made to most highways serving terminals, so that travel speeds are maintained at the 1970 levels.

Analysis Design

Many of the technologies described above are not likely to be widely introduced to all or a large number of corridors and city-pairs. Rather, they are likely to be specially tailored to market situations. To display these situations, certain of the technologies are applied to individual corridors and city-pairs as shown in Table 2.

*Including Chicago-St. Louis and Portland-Seattle.

Table 2

SCENARIO I ANALYSIS DESIGN

	Corridors	Large City-Pairs	Smaller/Closer City-Pairs
AIR	Reduced fare, but also reduced frequency	SST 900-Passenger jet Faster CTOL, reduced frequency	Discontinued services
RAIL	Some IPT (improved passenger train)	Mostly discontinued	Not Available (as at present)
BUS	←	70-mph speed limit	→
AUTO	Some electric highways		
	←	70-mph speed limit	→

III. TRANSPORTATION SCENARIO II

Introduction

Transportation Scenario II takes place within Background Scenario II, which is characterized by a national restraint on big business, encouragement of small business entrepreneurship and innovation, decentralization of population, and moderate economic growth.

Transportation Policies and Systems

The intercity transportation systems in operation in the year 2000 are regulated to emphasize service to small and medium sized cities and provide a variety of specialized services.

The fundamental descriptor of transportation within this scenario is eclectic variety--technically, operationally, geographically.

Federal policies regarding economic development, land use, and transportation emphasize growth of small industries and of small to medium sized cities. Assistance programs to fledgling transportation operators have been in operation under one office in the greatly expanded Small Business Administration. A loan guarantee program is also available for the acquisition of capital equipment.

To focus transportation's role in decentralizing population, Congress forms the Intercity Transportation Administration (ITA) within DOT, combining the Federal Aviation Administration (FAA), Federal Railroad Administration (FRA), and major segments of FHWA.

Two transportation research and technology programs within the government are very large, compared with their levels in the mid-1970s: small aircraft and buses. These programs lead to substantial advances. Interestingly, some basic research advances in turbine engine technology have found their way into both small aircraft and bus designs, although the applications of these advances into specific technologies differs substantially between the aircraft and bus modes.

Federal policies encourage state and local involvement in improving transportation, and with federal financial assistance, these levels of government are active in intercity transportation development.

Organizationally, the regulation of transportation at the federal level is the same as in earlier years. However, both the ICC and the CAB have taken a significantly different stance toward the solution of transportation problems than earlier. In consonance with the evolution of an anti-big-business philosophy in all sectors, transportation regulatory actions have diluted the strength of the large airlines, railroads, and bus companies, so that their roles are well-defined, carefully controlled, and concentrated on longer-haul missions. Virtually

every state has formed regulatory agencies for air and bus travel, and state regulatory agencies are considerably more powerful than in earlier years. The states discover a need for increased cooperation in regulatory matters, and bi- and multistate regulatory agencies are formed in appropriate instances.

The individual modes that are in service in the year 2000 are described in the following paragraphs.

Air Transportation. Although R&T programs of NASA and the ITA in air transportation have continued mostly along conventional lines (i.e., toward the development of aircraft of the sizes in common use by air carriers in the mid-1970s), the programs that receive the most public approval are those toward the development of small aircraft. By 1985, NASA was formally assigned a larger responsibility of improving general aviation technology, with concentration on air taxi and commuter aircraft.

A greatly expanded safety program was implemented, including research on improving vehicle safety and reducing pilot skill requirements. Low-cost microwave landing systems are in operation at a large fraction of the nation's public airports. Other ATC system improvements in operation are designed to improve the efficiency and safety of short-haul, low-altitude aircraft movements. Low-cost, solid-state avionics systems are in wide use, not only in commercial aviation, but in smaller, general aviation aircraft, as well.

In industry, two of the large airframe manufacturers are forced to form independent companies to develop small aircraft using simplified design approaches to reduce the cost of development. These subsidiary companies compete with the traditional small aircraft manufacturers for the increasing market in small transport aircraft.

Conventional takeoff and landing transport aircraft are somewhat improved and are operated by the airlines between large cities.

A Short Runway Aircraft (SRA) program has also been successful. The aircraft are designed to operate from airports with 4,000-foot runways (emphasis has been dropped on attempting to achieve a low-cost, 2,000-foot or 3,000-foot runway STOL aircraft). These aircraft are in operation by the airlines in a variety of locations, and are providing city-center to city-center service between large cities.

Small aircraft represent the most dramatic improvements that have been made in aviation. A small turbofan engine has been developed having significantly improved characteristics over those that appeared in the 1970s: lower cost, weight, noise, pollution emissions, and fuel consumption. Large advances in ceramic technology and in mass production techniques contribute to lowering its cost.

The improved engine, along with the use of composite materials, advanced aerodynamics, and solid-state avionics have produced a variety of small aircraft in both the commercial and recreational categories.

The small aircraft in commercial service--operated between small and large cities by new short-haul operators--offer lower fares and faster service than were offered by commuter carriers in earlier years, and these operators enjoy increased public acceptance and patronage.

Most airport development has occurred in small and medium cities: close-in new airports are built in some cities, and existing close-in general aviation airports are expanded for use by short-haul air carriers. Also, short, general aviation runways are added at larger airports.

Rail Transportation. Floundering portions of the U.S. rail network are nationalized: on these parts of the network, the federal government owns, maintains, and improves the rail lines, classification yards, terminals, and centralized traffic control systems. Railroad companies and some of the larger industrial firms operate their private equipment over the federal network.

In a move designed to preserve the financial viability of the larger railroads for freight service and to encourage entrepreneurship, the rail network facilities are provided to users on a marginal operating cost basis.

In spite of earlier investments in maintaining rail passenger service, AMTRAK, in the late 1980s, was seen as a noneconomic service that is not materially contributing to the achievement of national goals, and is discontinued.

A range of new rail passenger-vehicles are developed. The equipment types include individual, turbine-powered passenger cars that can be operated singly or in trains. For city-pairs connected by relatively direct rail lines, new entrepreneurs provide frequent, high-speed service between city centers. These services are afforded priority movement over the network.

A variety of other individualized services are offered by small private operators, taking advantage of special conditions. For example, auto-train service is available in a number of corridors. This service has gained in popularity for longer-distance travel relative to the use of the auto itself for the journey, because of evolution of the auto to smaller, less comfortable sizes.

Bus Systems. A significant advance in conventional buses is achieved as a result of breakthroughs in ceramic technology as applied to the turbine engine. A turbine engine--differing from aircraft turbine technology because of different weight requirements--is developed

for the 40 to 60 passenger bus and is widely used. Some of the components of the engine are mass produced on the same production lines that are being used to manufacture the turbofan aircraft engines. They offer low cost and low fuel consumption, noise, and pollution emission characteristics.

The bus vehicle is ten inches wider than was permitted in the 1970s, and as a result, it provides a more comfortable ride. It also costs less to produce than earlier due to economies of scale in manufacture made possible by increasing demands for buses in both urban and intercity service. Overall economic improvement, however, is limited by driver wage costs. (Of all of the intercity common carrier modes, bus transportation continues to experience the highest percentage of crew costs to total operating costs.)

Aided by various federal and state technical and financial assistance programs, bus operators provide frequent service to a range of markets, including relatively low-density markets, by using small passenger vans. Bus travel becomes more popular. A number of new bus manufacturers enter the market to satisfy the increased demand for vehicles.

Selective trial applications of dual-mode rail-bus vehicles are meeting some success in instances where feeder trip/line-haul trip distances are appropriate to that type of service.

Auto Systems. Automobiles have continued to evolve into smaller sizes, making them relatively unattractive for longer distance intercity travel. Also, the increasing use of the battery-powered electric vehicle in urban areas has tended to reduce the auto's intercity use.

Passenger vans and other special-purpose vehicles are widely available on a rental basis. With these services, families have become accustomed to owning small vehicles for in-city travel and renting larger vehicles for vacation trips.

Highway construction continues at a moderate pace. The Interstate Extension Program has selectively built new highways to provide improved connections to smaller communities. Highways are widened as necessary to permit use of the widebody bus.

Access/Egress Systems. Improvements in access/egress are characterized by a wide variety of services offered by individual entrepreneurs. Small operators provide increasingly popular off-airport parking and airport access service.

Some travel agents--especially in suburbs--expand their services and facilities to offer a ticketing, check-in, baggage handling, and airport transfer package. Other, non-travel-agent businessmen also establish off-airport terminals. Both types of operators are able to

obtain financial support for their operations from airlines and airport authorities, as well as from the charges to travelers.

Analysis Design

The technologies described above are applied to individual corridors or city-pairs as shown in Table 3.

Table 3

SCENARIO II ANALYSIS DESIGN

	Corridors	Large City-Pairs	Smaller/Closer City-Pairs
AIR[a]	Short runway aircraft	Lower fares for CTOL	Commuter services
RAIL[a]	IPT	← Discontinued →	
BUS[a]	More comfortable, lower fares		Some small van service
AUTO	← Improved fuel consumption →		

a. Access/egress improvements also occur.

IV. TRANSPORTATION SCENARIO III

Introduction

Transportation Scenario III takes place within Background Scenario III, which is characterized by consensus-oriented public decision-making, slow economic and population growth, increasing problems and inefficiencies in both the public and private sector, and little innovation. A major petroleum energy crisis takes place in the 1990s.

Transportation Policies and Systems

The intercity transportation sytems in operation in the year 2000 are experiencing financial difficulties and have not been successful in achieving marked technological advances. A significant impact on transportation operations in all modes is created by the energy crisis of the 1990s; research and technology efforts of the 1970s and 1980s were relatively well-directed in anticipation of the energy problem, so that some measures to reduce petroleum consumption could be implemented rather soon after the onset of the crisis.

Federal policies toward transportation in the 1980s are basically similar to those in other sectors: actions are reactive and ameliorative, rather than directed toward achieving substantial goals. Few guiding principles regarding federal decisions on transportation operations and on research and technology are apparent. With the impact of the energy crisis, however, NASA, DOT, and private industry, under the overall policy direction of the newly formed Energy and Resources Department, undertake to implement new energy-conserving transportation systems as a number one priority.

The CAB and the ICC policies regarding regulation and control of transportation evolve slowly toward giving more weight to user interests, and increased consideration in fixing rates is given to the cost basis concept, rather than the market-value basis. This trend has, at least partly, been due to a vastly increased Consumer Affairs Office in DOT, under a new Assistant Secretary, with the mandate to act as a transportation user advocate. The Office also represents user interests in local transportation hearings and policymaking. Overall, these actions tend to pressure for reduced passenger fares and freight rates, and for improved service through the 1980s. As a result, federal subsidies increase selectively to correct revenue-expense deficits. In the 1990s, regulatory decisions are increasingly affected by the energy shortage: for example, more approvals are given to requests to discontinue service on low-traffic-volume markets.

The transportation systems in operation are described in the following paragraphs.

Air Transportation. During the late 1970s and 1980s, airlines experience a number of difficulties. CAB decisions on maintenance of service to large and small markets alike and on keeping fares barely above costs produce trends toward increased costs and reduced revenue per passenger carried. As a result of the modest levels of economic growth, traffic increases only moderately, and the pessimistic forecasts of passenger and freight traffic growth that were made in the mid-1970s turn out to be higher than actually results. As internally generated capital declines, so also does the airlines' ability to attract investor capital and funds from the lending markets. As a result, there is little money available to invest in new aircraft, and the carriers are barely able to replace the aging fleet. No new aircraft designs are introduced; however, some improvements in fuel consumption and in noise and air pollution are achieved.

Labor-management problems seem to always be resolved in favor of labor, with attendant increases in crew and maintenance costs.

As economic pressures increase during the 1980s, the airlines are forced to take a number of actions: seat configurations of existing aircraft increase in density and higher load factors are achieved by reducing the frequency of service on many city-pairs. Airport maintenance falls off and terminal buildings become increasingly unpleasant because of their age, uncleanliness, and poor service.

Three major air disasters occur in 1989, and National Transportation Safety Board (NTSB) findings indicate that all three are a direct result of carriers' actions to defer aircraft maintenance to reduce expenses. A presidential commission recommends a drastic move: nationalization of the airlines. Action comes swiftly and with surprisingly little resistance.

By 1992, the air carriers are converted to a national corporation, the National Air Service.

During the 1990s, the National Air Service acts with other segments of the economy to reduce the impact of the energy crisis. A variety of operational measures are instituted to conserve fuel. Service is selectively curtailed, and the National Air Service is still attempting to achieve success in solving aviation problems in 2000, having made only limited advances up to that time.

Research and technology programs on the hydrogen-powered aircraft, which were modest in earlier years, are expanded significantly after 1990. Breakthroughs in nuclear breeder technology and in the development of a substantially more efficient liquefaction process than was thought possible in earlier years provide the leverage to begin full-scale development of the aircraft. By 2000, a number of prototype models are in operation, but introduction of passenger and freight aircraft using liquid hydrogen has not yet been accomplished.

Regarding the air traffic control system, major lobbying efforts of the Air Transport Association and the Aircraft Owners and Pilots Association during the 1980s are successful in stalling the FAA's programs toward more and more expensive black boxes. The failure of anticipated aviation growth to materialize also contributes to the situation. As a result, the ATC system of the late 1990s is only modestly improved over that of the 1970s.

Funding for airport development is also curtailed during the last twenty-five years of the century.. Contributing factors are reduced traffic growth, economic problems of the air carriers, and a successful move by the Consumer Affairs Office and private groups to reduce the 8% ticket tax to 4%. (This change, however, does not counterbalance the need on the part of the National Air Service to increase basic air fares to cover operating cost problems.)

Rail Transportation. Bankrupt railroads are reorganized under the CONRAIL concept, and additional roads are incorporated into the new public operation, so that by 1984, all railroads are nationalized.

AMTRAK is incorporated into the new national corporation. Consumer interests are given more weight, and passenger and freight service and equipment are improved substantially.

A high-speed advanced version of the Metroliner service is in operation on an intense basis in the fully electrified Northeast Corridor, and in other corridors as well.

Bus Service. Capitalizing on the airlines' difficulties during the 1980s, and on the bus's inherently low fuel consumption characteristics that become crucial during the fuel crisis of the 1990s, bus services are a very important element of the nation's intercity transportation system in the year 2000.

Bus companies are enjoying increased profits and are supporting research into vehicles and improved operating procedures at a higher level than in earlier years. Larger fleets are being operated with improved efficiency to the operators and improved service to the consumer. Improved passenger services, such as better schedule information and automated ticketing, are provided.

To further stimulate increased use of buses to conserve fuel, the ICC in 1993 approves lower fares for bus transportation. After strong lobbying by bus interests, Congress passes legislation to subsidize bus operation in view of the lower fares. Patronage increases markedly as a result of the improved service and lower fares.

New, quieter, and more comfortable vehicles also contribute to the growth of bus transportation in intercity markets.

Auto Systems. National pressures to reduce air pollution and fuel consumption of the automobile continue into and through the 1980s and politically expedient resolutions of yearly controversies on these matters continue. But the automobile inevitably becomes a smaller vehicle, with only marginal technical improvements in response to the above issues.

The energy crisis of the 1990s produces both policy and technological actions of substantial magnitude.

The Energy and Resources Department enforces a Congressional mandate to specially license automobiles for intercity travel. Licenses are granted for legitimate business intercity travel, and special tags are issued to reduce the annual number of trips made by auto for personal reasons in intercity travel. The states implement the federally mandated actions, such that unrestricted use of the nonbusiness auto is permitted only in the owner's county of residence and in immediately adjacent counties. The effect of the regulations is to reduce intercity automobile trips by one-half.

Research and technology programs are significantly increased to improve fuel economy and substantial improvements are achieved.

During the last quarter of the century, highway construction falls off considerably. The interstate program is largely completed, but environmental groups are successful in stalling many other highway projects. Another major contributing factor is the reduced revenues accruing to the highway agencies as a result of lower levels of travel.

Access/Egress Systems. Not much progress is made in improving the passenger's trip to and from airports and rail and bus terminals. With highway construction limited, congestion increases. Only late in the 1990s does recognition of the impacts of urban congestion on fuel consumption become wide enough to regenerate some highway widening and new freeway construction.

Bus system improvements have dominated the urban transit improvements; technology has been neither encouraged nor successful in producing advanced transit systems. Also, in the late 1970s, Congress and DOT firmly concluded that new installations of high-cost conventional rail rapid transit systems would not be federally funded.

Analysis Design

The technologies described above are applied to individual corridors or city-pairs as shown in Table 4.

Table 4

SCENARIO III ANALYSIS DESIGN

	Corridors	Large City-Pairs	Smaller/Closer City-Pairs
AIR[a]	Higher fares	Higher fares	Higher fares, reduced frequency
RAIL[a]	IPT	Increased frequencies	Increased frequencies
BUS[a]	← Lower fares →		
AUTO	← Regulations curtail intercity use →		

a. More time and cost for access/egress.

V. TRANSPORTATION SCENARIO IV

Introduction

Transportation Scenario IV takes place within Background Scenario IV, which is characterized by a strong government focusing its programs on achieving social welfare goals.

Transportation Policies and Systems

The intercity transportation system in operation in the year 2000 is heavily oriented toward helping to achieve broader societal goals, such as decentralization of population and economic activity. Centralized governmental actions also concentrate on producing efficient transportation services.

Intercity transportation services provided by air, fixed guideway, bus, and auto systems are all significantly improved by the year 2000. Steps were taken to achieve a more fully integrated multimodal transportation system by reducing uneconomic competition within and among the modes and improving modal interfaces in both passenger and freight transport.

Federal involvement in transportation includes vigorous research and technology programs, capital and operating subsidies of private modes, and federal ownership of the national railroads. State governments, as well as special single- and multipurpose, multistate and regional agencies also are active in providing transportation services.

The Interstate Transportation Board (ITB) was created by the Congress in 1985 to replace the CAB, the ICC, and the NTSB, and has wide responsibilities across modes to improve not only economic performance but transportation safety and socially desirable services. By the year 2000, it is succeeding in implementing major changes in the nation's intercity passenger transportation system. Among the changes are a more highly organized airline route network utilizing a "trunk and spoke" concept and reduced intermodal competition in certain corridors that result in improved economies of scale.

The individual modes that are in service in the year 2000 are described in the following paragraphs.

Air Transportation. Government-sponsored basic research and technology efforts resulted in major advances in aircraft, airport, and air traffic control systems that improved their economic performance, capacity, and safety.

Aircraft improvements due to a number of advances, including improved transonic airfoils, the widespread use of composite materials, and

active (aircraft) control technology produced a range of aircraft with appreciably lower direct operating costs and lower fuel consumption than were available in 1975. Transonic airfoil aircraft are operated at mid-1970 speeds--M = 0.82--in order to gain the fuel economies that result at those speeds. Increased environmental priorities during the 1980s and 1990s cause noise and air pollution emission characteristics to be significantly improved. The physical appearance of aircraft are not changed appreciably from earlier years. Increasing numbers of short-haul aircraft systems are in operation in markets where their operational characteristics and market setting makes them attractive. Lighter-than-air vehicles have also come into use providing specialized transportation services similar to ferry services in a small number of markets.

New airports were constructed in a number of medium-sized cities by the year 2000, but, because of emphasis on increasing the efficiency of air operations, few major new airports in large cities were completed. Subtle but significant improvements in passenger processing efficiency are achieved through the use of more highly automated ticketing; advanced security checking; intra-airport ride systems; improved, computer-assisted aircraft ground movement control; and improved baggage handling devices. Transfer between planes is much easier, because of some terminal reconstruction and the ride systems. Such improvements at the major transfer airports are crucial to the success of the new "trunk and spoke" air system.

A fourth generation, satellite-centered air traffic control system, a highly computerized outgrowth of NASA and DOD satellite technology, is installed in the late 1990s. This system provides centralized control and monitoring of all air carrier and many general aviation aircraft en route movements. It also provides improved traffic control and metering and spacing of aircraft in the terminal area airspace, thus reducing air controller workload and airborne delays appreciably. Aircraft travel times are 6% less than 1975.

Fixed Guideway Transportation. Although DOT-sponsored research and technology efforts on advanced fixed guideway systems had lost momentum during the 1970s, they gained stature in the 1980s as a result of a number of factors. These included a widespread recognition of their lower energy consumption, along with their use of electrical rather than petroleum energy, and a growing appreciation of the advantages in service that a high-speed, city-center-to-city-center system could provide.

The major technological advance that moved the tracked levitated vehicle (TLV) system into the realm of feasibility was not in the fields of vehicle suspension and propulsion subsystems, which had received earlier priorities in research programs, but in the field of guideway construction. Mammoth semiautomated construction machinery enabled guideway construction at a fast pace and at significantly lower costs than had been envisaged in the mid-1970s. These economies permitted installation of TLV systems in a larger number of corridors than had been thought

feasible in earlier days. TLV services are provided only over short-to-medium distances in corridors where passenger traffic is relatively dense. The strong environmental interests resulted in substantial development efforts to reduce the noise of the TLV vehicle. The TLV services are operated by multistate public agencies with federal subsidy. These agencies have established and maintained friendly, cooperative relations with the ITB. The ITB keeps air transportation competition to a minimum in these corridors (an act which also aided in establishing the feasibility of the new air traffic control system).

In addition to proving highly attractive for passenger travel, the TLV service is also being used extensively by businesses and the Postal Service for high-speed, same-day mail and parcel delivery. Automatic sorting equipment aids in establishing the attractiveness of this service.

Improved passenger train service is also utilized selectively, although the nationwide AMTRAK network had been substantially reduced for economic reasons.

Bus Systems. Although technical improvements achieved in the performance, cost, and fuel economy of bus service are marginal, the inherent advantages of bus travel is more widely appreciated in the year 2000.

Aided by ITB decisions that permit operators to use wider bodied vehicles and to travel at a speed of 75 miles per hour (120 kilometers per hour) on dedicated highway lanes--contrasted to the auto speed limit of 55 miles per hour (88 kilometers per hour), bus travel is more comfortable and more attractive in terms of travel time. In addition, economic incentives created by new legislation permitted the development of multimodal terminals that make air-to-bus and TLV-to-bus transfers more acceptable to travelers, thus facilitating the development of increased specialization of the total national intercity transportation system. A federally supported program toward facilitating travel by the handicapped and the aged has been in effect for some years and has resulted in bus designs which ease the travel burdens of these people.

Finally, fare and subsidy policies established by the ITB enables bus services to be offered at relatively low prices. (Subsidies to intercity transportation system operators have been justified because of the social goal of population decentralization and, in the case of buses, energy conservation.) Many of the shorter-haul intercity bus operations are provided by state and regional government transportation agencies.

Auto Systems. Federal legislation and policies toward reducing fuel consumption and air pollution of the automobile continued during the 1980s, so that the auto of the year 2000 is a much different vehicle

than was used in the 1960s. The social ethics of the latter years of the twentieth century also contributed to this evolution, which resulted in smaller, efficient vehicles that were valued for their transportation service and not much more.

Although electrically-powered vehicles using new, efficient advanced battery technology are commonly used for intraurban travel, the petroleum-fueled vehicle is still predominant in intercity use. Because private auto ownership has declined, many businesses and families take advantage of the low-cost, rental vehicle services provided by municipal transit agencies. Shared vehicle ownership and use increases, especially in new, high density residential communities.

Highway construction, which slowed in the 1970s due to environmental and economic pressures, continues at a slow pace during the 1980s and 1990s. The major program, both in the cities and on the rural interstate highway system, was oriented to providing facilities that improved the efficiency of bus operations. This program resulted in new lane markings that widened one lane for 75-mile-per-hour buses and trucks and reduced the widths of the other lanes (while still providing adequate safety because of the narrower widths of automobiles).

Access/Egress Systems. Overall, the actions of the federal government during the 1980s and 1990s in the transportation field were more predominant in urban transportation than in intercity transportation. Subsidy programs for capital investments and for operations continued to grow beyond the levels of the 1970s. Research and technology programs were also accelerated, driven by an increasingly energy- and air pollution-conscious Congress.

In a few larger cities, existing and new fixed guideway rapid transit systems are extended to airports and TLV terminals. Because these systems, along with their supporting bus feeder systems, were installed in urban areas with relatively broad geographical coverage, many intercity travelers use them for access and egress to the intercity terminal. Notable among the successes for the heavy rail transit extensions are those in New York, Washington, D.C., and San Francisco.

Late in the twentieth century, the first areawide installations of personalized, fixed guideway systems using vehicles under automatic control were completed. In conjunction with the rental electric automobile systems, these systems are popular and widely used for urban travel. Of course, network connections to airports and TLV terminals made them attractive for the access/egress segments of intercity trips.

Analysis Design

Some of the technologies described above are applied to individual corridors or city-pairs as shown in Table 5.

Table 5

SCENARIO IV ANALYSIS DESIGN

	Corridors	Large City-Pairs	Smaller/Closer City-Pairs
AIR[a]	Reduced frequency of service	Cheaper, faster CTOL	Improved small aircraft services
RAIL[a]	TLV	Mostly discontinued	Some new routes
BUS[a]	←	Lower fares 75-mph speed limit	→
AUTO	←	Improved fuel consumption	→

a. Large improvements to intercity access/egress because of urban transportation improvements.

Appendix A

LIST OF ACRONYMS

A/C	Aircraft
AMTRAK	National rail passenger service
ATC	Air traffic control
CAB	Civil Aeronautics Board
CONRAIL	Consolidated Rail Corporation
CTOL	Conventional takeoff and landing aircraft
DOD	Department of Defense
ICC	Interstate Commerce Commission
IPT	Improved passenger train
ITA	Intercity Transportation Administration (a postulated DOT agency)
ITB	Interstate Transportation Board (a postulated regulatory agency)
NTSB	National Transportation Safety Board
PSA	Pacific Southwest Airlines, intrastate airline in California
R&T	Research and technology
SRA	Short runway aircraft (a postulated technology)
SST	Supersonic transport
STOL	Short takeoff and landing aircraft
TLV	Tracked levitated vehicle

PART C

ANALYSIS OF TRANSPORTATION SCENARIOS

by

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PART C

ANALYSIS OF TRANSPORTATION SCENARIOS

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I. INTRODUCTION

This report is one of a series designed to assist in identifying and evaluating future intercity transportation system impacts. It presents quantitative descriptions and analyses of intercity transportation systems that might be in operation in the year 2000.

Four sets of analyses are presented; one for each of the study's "transportation scenarios." These transportation scenarios and the design for the analyses are described in Part B of this volume. The analyses in this report also draw on information from Part A of this volume, *Background Scenarios of Possible Future States of Society;* and Volume 3, *Technological Characteristics of Future Intercity Transportation Modes.* The reader is encouraged to review these materials before considering the analytical results described here.

Nature of Scenarios

As indicated in Part B, the transportation systems postulated for analysis are substantially different from those in operation today. Among the most important differences are those below:

1. New technologies are postulated, some of which have characteristics implying significant technical invention or breakthrough.

2. Competitive conditions within the transportation industry vary widely among the scenarios. Important regulatory changes are postulated.

3. The technologies are studied within the context of widely varying future states of society.

Within the limits of the methodologies used, all of these changes significantly influence the results of the scenario analyses.

Analysis Design

As described in Part B, the design for analysis of the transportation scenarios included selection of travel settings and definition of reference or baseline conditions against which the impact of transportation scenarios can be measured.

The case study approach to travel settings introduces a degree of realism to the application of technologies in terms of volumes of travel and trip distances. However, the selected travel settings should be viewed as case examples within the context of the potentially more widespread

introduction of new technologies. The scope of this study does not permit evaluation of a large enough number of cases so that quantitative extrapolations to the national potential of a technology can be made. Thus, appraisals of full national impacts (e.g., total revenue passenger miles of travel by a given technology) must be largely qualitative in nature.

To provide a basis for measuring impacts of the transportation systems postulated in a given scenario, a set of four reference cases is also postulated--one reference case for each background/transportation scenario. The common feature among the four reference cases is that each assumes the same transportation technology for the year 2000. For all modes, only nominal improvements, if any, are postulated relative to today's systems (e.g., somewhat larger vehicles and higher passenger load factors for public modes, marginally improved fuel efficiency for automobiles). The features that cause the reference cases to differ from one another are the background scenario conditions associated with each: population, income, wage rates, cost of capital, and price of fuel.*

The background scenario conditions for each transportation scenario and its respective reference case are "constant"; this provides the basis for comparing the two in terms of the "variables"--transportation innovations. Whenever a term such as "higher" or "lower" is used in a transportation scenario, it means the factor is higher or lower than in the reference case. Because of variations in both transportation innovations and background conditions, *comparisons cannot be readily drawn between transportation scenarios.*

Organization of This Report

Chapters II through V of this report represent the analytical results for Scenarios I through IV. A summary of transportation system innovations is presented in each chapter, along with data on patronage, revenues and operating costs, energy consumption, and safety.

Appendix A provides quantitative descriptions of the transportation systems applied to the four scenarios. Appendix B briefly describes the analytical technique used to estimate travel demand. The description includes some important provisos regarding use of the technique for this study.

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*Statements regarding costs in this report are in terms of constant dollars.

II. TRANSPORTATION SCENARIO I

Introduction

The setting for Transportation Scenario I is characterized by national emphasis on economic growth, encouragement of business, and substantial advances in research and technology that have been placed in service on a large scale mostly by private industry.

Population and income growth trends have generally been conducive to growth in intercity travel. As indicated in Table 1, real personal income by the year 2000 is about twice that of the early 1970s. (While substantial, the income growth is considerably below forecasts made in the early 1970s.)

Other economic trends tend to discourage intercity travel through their effect on transpotation costs and fares; fuel prices and wage rates are high, as is the rate of interest on borrowed funds.

Overview of Transportation Innovations

In Scenario I, there are a number of innovations in transportation policies, systems, and hardware. Most of the changes--for example the environmentally acceptable supersonic aircraft (SST)--have proved beneficial in some degree to travelers, carriers, and/or the public, but others have not met expectations--most notably, the changes in air transportation service related to introduction of the giant-jet.

Air Transportation. Relaxed economic regulatory controls have led to only a few large carriers providing scheduled air service. These carriers make a number of service changes in the interest of profit maximization. Air service is discontinued at many small cities and flight frequencies are reduced in even the most dense air travel markets.* On the other hand, technological improvements in aircraft and air traffic control yield some reductions in flight times. Where service is offered, the increased speeds roughly cancel the effect of reduced frequencies in terms of passenger convenience. As discussed below, the principal hardware-related innovations are transcontinental SST service and giant-jet (900-passenger) aircraft.

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*Schedules are based on achieving a "target" load factor of 60% (average percentage of seats occupied) which is about five percentage points higher than the 1970s. In most cases, this goal is met or exceeded in Scenario I.

Table 1

BACKGROUND SCENARIO I DATA

Corridor or City	Population (000) Year 2000	Population (000) Multiple of 1971	Total Personal Income (millions of 1967 dollars) Year 2000	Total Personal Income (millions of 1967 dollars) Multiple of 1971
Northeast Corridor	42,684	1.3	$294,787	2.1
Chicago-St. Louis Corridor	12,160	1.3	83,564	2.0
Seattle-Portland Corridor	3,638	1.3	24,020	2.2
Los Angeles	9,116	1.3	63,416	2.1
Washington, D.C.	5,190	1.8	36,007	2.7
Boston	4,996	1.3	33,573	2.2
Denver	1,981	1.6	12,197	2.4
Dallas/Ft. Worth	3,590	1.5	21,960	2.6
Traverse City	63	1.3	225	2.0
Detroit	5,323	1.3	36,379	2.0
Atlanta	2,465	1.7	15,281	2.7
Kansas City	1,793	1.4	11,377	2.2
Oklahoma City	1,028	1.6	5,837	2.6
Stockton	334	1.1	2,111	1.8
Fresno	455	1.1	2,666	1.7
Billings	102	1.1	568	1.9

Fuel price as a multiple of 1974 price = 2.85
Labor wage rates as a multiple of 1974 rates = 1.25
Prime interest rate (vs 8% in 1974) = 11.5%

Rail Service. Although rail service is discontinued in many long-distance markets, improved frequencies and other service amenities on the remaining network yield substantial increases in patronage in many instances--in spite of competition from high-speed buses and autos. In some corridors, rail must also compete with reduced-cost, "no-frills" air service but ratains its market share.

Improved high-speed passenger train service (IPT) is selectively introduced by AMTRAK (e.g., Seattle-Portland). Measured in terms of patronage, IPT is a resounding success.

Bus Service. A 70-mile-per-hour highway speed limit and high gasoline prices contribute to nationwide increases in bus patronage. Traffic increases are pronounced in low-density travel markets where air service is discontinued.

Auto Systems. Automobiles continue to represent the dominant mode of travel in many intercity markets even though high gasoline prices have resulted in relatively modest increases in auto traffic relative to the 1970s (10% to 50% increases). Much of this growth is attributable to the 70-mile-per-hour speed limit of Scenario I.

Electric highway demonstration programs have sharply reduced travelers' perceived cost of intercity auto travel, owing to technological breakthroughs that provide low cost electricity and transmission hardware. In the absence of innovations for other transportation modes, auto travel has increased by over 40% where electric highways are available. Improved passenger train service is a formidable competitor to electric highways where both services are offered (e.g., Seattle-Portland).

Mode Descriptions. Service characteristics for the transportation innovations outlined above are among those quantified in appendix A, where speed, cost, and other information is presented by mode.

Patronage

A capsule summary of traveler responses to the transportation innovations of Scenario I is set forth in Table 2. The basis of comparison is "Reference Case I." Travel levels for the Reference Case reflect pertinent background scenario information (i.e., Table 1) but, as indicated in Appendix A, include only modest changes in other transportation service charactreistics from those of the 1970s.

As indicated in Table 2, intercity traffic levels for Scenario I are higher than those of Reference Case I for most modes in most geographic settings. In the paragraphs that follow, selected case studies of transportation service innovations are described.

SST, Los Angeles-Washington. Breakthroughs leading to the introduction of supersonic aircraft in transcontinental service include solutions for aircraft noise and emission effects *and* operating cost reductions, such that fares for the SST exceed those of conventional aircraft by only 30%.

Table 2

SUMMARY PATRONAGE RESULTS FOR SCENARIO I
(Compared with Reference Case I)

Mode	High-Density Travel Corridors[a]	Large City-Pairs[b]	Smaller and/or Shorter Distance City-Pairs[c]
Air	Little change where fare reductions counter decreased frequencies; otherwise a 20% drop in patronage.	In general, little change in traffic levels (increased speed counterbalances decreased frequencies). SST and giant-jet discussed in text.	Very low patronage (widespread discontinuance of service).
Rail	Travel up by a factor of 7 where IPT is offered; otherwise no net change.	Patronage up by a factor of 3 where service is offered (increased frequency).	Patronage up by a factor of 3 where service is offered (increased frequency).
Bus	Patronage up by 10% to 20%, (higher speeds).	Travel up by 20% to 40% (competitive position enhanced by increased speed).	Traffic up by a factor of 2 (increased speed and frequency).
Auto	Traffic up by: 20% without electric highways (higher speeds). 40% with electric highways (higher speeds and lower cost).	10% to 30% increases in traffic (higher speeds).	20% to 40% increases in traffic (higher speeds).
Total Traffic	Travel increases of 10% to 40%.	In general, little change (air is dominant mode).	Range from 40% decreases (where air had been dominant mode) to 20% increases.

a. Northeast Corridor (Boston-Washington), Chicago-St. Louis, and Seattle-Portland.
b. Los Angeles-Washington, Boston-Denver, Los Angeles-Dallas/Fort Worth, and Atlanta-Detroit.
c. Detroit-Traverse City, Kansas City-Oklahoma City, Stockton-Fresno, and Denver-Billings.

In the Los Angeles-Washington market, both conventional and SST service is offered:

	Flight Time (hours)	One-Way Fare (y-class)	Flights per Day
SST	2.1	$230	4
Conventional	4.4	175	18

About one-third of business travelers select the SST, suggesting that they value their time at more than $25 per hour (or that the air fare is passed on to others as a business expense). Surprisingly, about one-quarter of nonbusiness air travelers also choose the SST. (A novel feature of westbound flights is arrival in California one hour earlier than departure time in Washington.) In total, demand for SST service is sufficient to allow for two supersonic aircraft to be assigned to the Los Angeles-Washington route.

As with other transportation service improvements, introduction of the SST induces (stimulate) travel. There are new travelers between Los Angeles and Washington and more frequent trips by those who traveled before. Thus, while the SST is heavily patronized, the reduction in conventional air service patronage is relatively small. SST service between Los Angeles and Washington is provided as part of a more extensive route structure. Demand for SST service in the Los Angeles-Washington market is such that if SST aircraft were dedicated to the route, two aircraft would be required. However, each would be in operation for only about 10 hours per day.

Giant-Jet, Los Angeles-Dallas/Ft. Worth. In contrast to the success of the SST the 900-passenger aircraft has not proved attractive to air travelers and scheduled airlines.

Economies of scale--primarily a one-third reduction in direct operating cost per seat-mile--would allow a 12% reduction in giant-jet fares relative to conventionally sized (e.g., 300- to 400-seat) aircraft in the Los Angeles-Dallas/Ft. Worth market. However, this fare reduction is possible only with a high (60%) load factor. Because growth in air travel by the year 2000 does not reach the levels forecast in the late 1960s, airlines must sharply reduce flight frequencies of the giant-jets to fill them. A related step eliminates some nonstop flights (e.g., Los Angeles-Oklahoma City) and reroutes traffic (e.g., Los Angeles-Dallas-Oklahoma City). These steps prove unpopular to air travelers in spite of attendant fare reductions. Air traffic levels fall by 20% where the giant-jet is introduced.

No-Frills Air Service, Boston-Washington. The single airline which serves the Boston-Washington air travel market institutes "no-frills" service in order to reduce indirect operating costs. Service features include high-density, coach-only seating in 300-seat aircraft, instant-payment sales at time of boarding, and little baggage handling. As a result, the airline experiences a 32% reduction in total operating costs (50% of indirect operating costs). After experimenting with various combinations of flight frequencies and fare reductions to maximize profits, the airline settles on a policy that reduces fares by 16% and flight frequencies by 20%.

Partly because of service improvements by other modes (e.g., rail, bus, and auto), but primarily because frequency reductions have counterbalanced fare reductions, air passenger traffic in the Boston-Washington market remains at levels like those prior to intorduction of the no-frills service. Demand analysis data for the case are provided in Table 3.

Air Service Discontinued, Detroit-Traverse City. Widespread discontinuances of scheduled air service in low-density markets occurs in Scenario I. The route from Detroit to Traverse City, Michigan, is reasonably typical of the outcome for cities 150 to 250 miles apart.

Although air trips accounted for one-quarter of total trips before discontinuance, the loss of this service is more than counterbalanced by speed and frequency improvements for bus and speed increases for auto.* As shown in Table 4, the net effect is to increase total travel between Detroit and traverse City.

Surface Modes, Seattle-Portland. Both electric highway and IPT service are introduced in the Seattle-Portland corridor in Scenario I. As shown in Table 5, electric highway service reduces the cost of highway travel. Travel time is also reduced because there is a 70-mile-per-hour speed limit for all highway vehicles. For IPT, fares are doubled, but travel time is halved.

The effect of these and other service changes between Portland and Seattle is to stimulate total travel and yield an increased market share for the IPT service relative to conventional rail service. An important contribution to the high traffic levels for IPT is the frequency of service that can be provided, given other attractive features of the mode.

*The highway speed limit in Scenario I is 70 miles per hour.

Table 3

DEMAND ANALYSIS--SCENARIO I
Boston-Washington, D.C.

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--No-frills service	2.9 (3.0)	$50.40 (59.48)	21 (26)
Rail	9.6 (9.6)	31.40 (31.40)	8 (7)
Bus (70-mph speed limit)	10.5 (12.5)	24.00 (24.00)	32 (32)
Auto (70-mph speed limit)	8.5 (9.7)	21.00 (21.50)	

	Scenario I	Reference Case I	Early 1970s
Patronage			
Total Annual Passengers (millions)	1.8	1.6	0.8
Air	1.1	1.0	0.4
Rail	0.1	0.1	0.1
Bus	0.3	0.2	0.1
Auto	0.3	0.3	0.2
Market Shares (% of passenger trips)			
Air	60%	61%	57%
Rail	8	8	8
Bus	13	12	10
Auto	19	18	25

a. Values in parentheses are for Reference Case I.

Table 4

DEMAND ANALYSIS--SCENARIO I
Detroit-Traverse City, Michigan

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air	scheduled service discontinued in scenario		
Bus (70-mph speed limit	4.9 (5.8)	$13.00 (13.00)	8 (5)
Auto (70-mph speed limit)	4.3 (4.9)	11.20 (11.20)	

	Scenario I	Reference Case I	Early 1970s
Patronage			
Total Annual Passenger (thousands)	157	149	109
Air	0	35	18
Bus	32	16	7
Auto	125	98	84
Market Shares (% of passenger trips)			
Air	0%	24%	17%
Bus	20	10	6
Auto	80	66	77

a. Value in parentheses are for Reference Case I.

Table 5

DEMAND ANALYSIS--SCENARIO I
Portland-Seattle City-Pair

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air	1.9 (2.0)	$37.10 (37.10)	26 (32)
Rail--IPT	2.5 (4.6)	23.35 (10.58)	18 (3)
Bus	3.8 (4.5)	9.50 (9.50)	15 (15)
Auto (including electric highway)[b]	2.8 (3.2)	5.80 (7.10)	

	Scenario I	Reference Case I	Early 1970s
Patronage			
Total Annual Passengers (millions)	5.4	4.0	2.7
Market Shares (% of passenger trips)			
Air	22%	36%	27%
Rail	20	3	2
Bus	13	17	11
Auto	45	44	60

---

a. Values in parentheses are for Reference Case I.
b. It is assumed that 70% of autos are equipped for electric highways and use the service. The remaining autos are gasoline powered. Travel cost shown is an average for the two types of autos.

Carrier Operating Costs and Revenues

The theme of profit-maximization that underlies Scenario I is evident in Table 6, which sets forth cost and revenue data for the scenario and its reference case.

Energy Consumption

Indices of energy consumption for Scenario I are given in Table 7. On a passenger-mile basis, consumption is down for most geographic settings--particularly where electric highways and/or IPT are introduced or where air service is discontinued. SST service between Los Angeles and Washington has increased energy consumption per passenger-mile.

Total energy consumption for each geographic case depends on passenger-mile consumption *and* traffic levels. For Scenario I, most cases examined (7 of 11) experience an increase in total energy consumption.

Traffic Safety

An index of traffic safety for Scenario I (as for other scenarios) is obtained by combining applicable traveler fatality rates from Appendix A with data on passenger-miles by mode for Appendix C. The results for Scenario I--expressed as expected number of traveler fatalities--are given in Table 8. Because travel levels and market shares by mode are generally the same for Scenario I and its Reference Case, differences in accidents (fatalities) appear to be small.

Table 6

REVENUES AND COSTS[a] SCENARIO I
(Thousands of 1974 Dollars)

Mode and Category		Northeast Corridor		Chicago-St. Louis Corridor		Seattle-Portland Corridor		Los Angeles-Wash.D.C.		Boston-Denver		Los Angeles-Dallas/Ft. Worth	
		Scenario	Reference	Scenario	Reference	Scenario	Reference	Scenario	Reference	Scenario	Reference	Scenario	Reference
AIR	Gross Revenue[b]	$309,983	$358,150	$32,223	$39,356	$31,972	$39,058	$356,913	$102,401	$24,732	$24,412	$53,245	$75,848
	Operating Cost	251,086	340,385	26,101	37,404	29,005	37,121	336,203	97,322	22,437	23,201	52,904	72,086
	Net Revenue	58,897	17,764	6,122	1,952	2,967	1,937	20,710	5,079	2,295	1,211	341	3,762
RAIL	Gross Revenue	234,149	242,983	2,379	2,413	29,087	1,322	--	511	385	132	--	415
	Operating Cost	337,174	349,895	3,426	3,475	26,469	1,918	--	736	554	190	--	597
	Net Revenue (Deficit)	(103,025)	(106,912)	(1,047)	(1,062)	2,618[c]	(586)	--	(225)	(169)	(58)	--	(182)
BUS	Gross Revenue	127,823	107,552	8,531	7,688	5,853	5,543	1,093	949	659	501	2,760	2,004
	Operating Cost	115,041	96,797	7,678	7,150	5,268	5,155	984	883	593	466	2,484	1,864
	Net Revenue	12,782	10,755	853	538	585	388	109	66	66	35	276	140

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual routes.
b. Fare revenues less ticket tax of 8%.
c. It is assumed that this amount is used for guideway costs and vehicle costs.

Table 6 (cont.)
REVENUES AND COSTS[a] SCENARIO I

Mode and Category		Detroit-Traverse City Scenario	Detroit-Traverse City Reference	Atlanta-Detroit Scenario	Atlanta-Detroit Reference	Kansas City-Oklahoma City Scenario	Kansas City-Oklahoma City Reference	Stockton-Fresno Scenario	Stockton-Fresno Reference	Denver-Billings Scenario	Denver-Billings Reference
AIR	Gross Revenue[b]	$ --	$1,344	$20,866	$21,360	$1,311	$4,740	$ --	$65	$ --	$3,592
	Operating Cost	--	1,278	18,929	20,301	1,189	4,505	--	62	--	3,414
	Net Revenue	--	67	1,936	1,059	122	235	--	3	--	178
RAIL	Gross Revenue	--	--	--	16	139	42	--	--	--	--
	Operating Cost	--	--	--	23	200	60	--	--	--	--
	Net Revenue (Deficit)	--	--	--	(7)	(61)	(18)	--	--	--	--
BUS	Gross Revenue	320	152	467	367	857	406	175	83	497	218
	Operating Cost	288	141	420	341	771	378	158	77	447	203
	Net Revenue	32	10	47	26	86	28	18	6	50	15

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual route

b. Fare revenues less ticket tax of 8%.

Table 7

ENERGY CONSUMPTION
SCENARIO I

Geographic Setting	Per Passenger-Mile Consumption Relative to Reference Case[a]	Total Energy Consumption Relative to Reference Case[b]
Northeast Corridor	1.021	1.147
Chicago-St. Louis Corridor	0.882	1.111
Seattle-Portland Corridor	0.742	1.086
Los Angeles-Washington, D.C.	1.232	1.629
Boston-Denver	0.983	1.035
Los Angeles-Dallas/Ft. Worth	0.848	0.717
Atlanta-Detroit	0.987	1.001
Detroit-Traverse City	0.856	0.935
Kansas City-Oklahoma City	0.816	0.852
Stockton-Fresno	0.947	1.157
Denver-Billings	0.668	0.470

a. Btu per passenger-mile for scenario divided by Btu per passenger-mile for reference case.
b. Calculated Btu for scenario divided by calculated Btu for reference case.

C-2

Table 8

TRAFFIC SAFETY INDICES
SCENARIO I

Geographic Setting	Expected Number of Annual Traveler Fatalities[a] Scenario	Reference Case
Northeast Corridor	123	92
Chicago-St. Louis Corridor	11	9
Seattle-Portland Corridor	7	7
Los Angeles-Washington, D.C.	6	4
Boston-Denver	1	1
Los Angeles-Dallas/Ft. Worth	4	3
Atlanta-Detroit	1	1
Detroit-Traverse City	1	*
Kansas City-Oklahoma City	1	1
Stockton-Fresno	*	*
Denver-Billings	*	*

Note: Asterisk (*) denotes a value of less than 0.5.

a. Product of route passenger-miles and assumed national accident rates (see Appendix A) by mode.

III. TRANSPORTATION SCENARIO II

Introduction

The setting for Transportation Scenario II includes national restraint on big business, encouragement of small business, and decentralization of population.

Population and economic trends have been moderately favorable to growth in intercity travel. As shown in Table 9, population growth has been relatively high and real personal income has grown at a somewhat faster rate, leading to small gains in real personal income on a per capita basis. Fuel prices are double those of 1974 and the prime interest rate is two percentage points higher. Wage costs are unchanged (in contant dollars) from 1974 levels.

Overview of Transportation Innovations

A fundamental descriptor of transportation in this scenario is variety--widely differing systems have been implemented in different geographic settings. Service characteristics for the modes of Scenario II are among those quantified in Appendix A.

Air Transportation. Conventional takeoff and landing aircraft are operated by the airlines in long-haul service between large cities. These aircraft are large--averaging 250 seats*--and are improved in fuel economy and other direct operating cost characteristics relative to aircraft of the 1970s. Commuter aircraft in a variety of sizes are operated by new small airlines in less dense, shorter-distance routes. These services are of a "no-frills" nature which, when coupled with technological aircraft advances, allow for low operating costs. Competition among the smaller airlines causes the cost savings to be reflected in low passenger fares.

In high-density transportation corridors, short-runway aircraft services are introduced. The aircraft operate from airports (with 4,000-foot or longer runways) located closer to the true origins and destinations of travelers than long-haul airports. Technological advances lead to short-runway aircraft with operating cost and speed characteristics like conventional aircraft; travelers benefit because of reduced access time and cost.

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*In the early 1970s, average aircraft size on such routes was about 170 seats.

Table 9

BACKGROUND SCENARIO II DATA

Corridor or City	Population (000) Year 2000	Population (000) Multiple of 1971	Total Personal Income (millions of 1967 dollars) Year 2000	Total Personal Income (millions of 1967 dollars) Multiple of 1971
Northeast Corridor	49,000	1.5	$248,633	1.8
Chicago-St. Louis Corridor	14,065	1.5	71,531	1.7
Seattle-Portland Corridor	4,653	1.6	21,833	2.0
Los Angeles	12,590	1.8	65,402	2.1
Washington, D.C.	5,003	1.7	25,261	1.9
Boston	5,873	1.6	27,651	1.8
Denver	2,198	1.7	9,419	1.9
Dallas/Ft. Worth	4,540	1.9	20,210	2.4
Traverse City	76	1.5	198	1.8
Detroit	6,428	1.5	31,979	1.8
Atlanta	2,693	1.9	12,368	2.2
Kansas City	2,135	1.7	10,053	2.0
Oklahoma City	1,072	1.6	4,500	2.0
Stockton	399	1.3	1,896	1.6
Fresno	580	1.4	2,601	1.7
Billings	109	1.2	462	1.5

Fuel price as a multiple of 1974 price = 2.07
Labor rates as a multiple of 1974 rates = 1.00
Prime interest rate (vs 8% in 1974) = 10%

Rail Service. Except in the case of high-density travel corridors, rail passenger service is discontinued. In the corridors, one of the types of service that is operated by private operators is improved passenger train service.* These are high-speed (110-miles-per-hour block speed) systems with fares set to recover full costs.

*Other services postulated for this scenario, such as auto-train service, are not analyzed.

Bus Systems. Intercity buses are wider, and thus more comfortable for passengers than those of the 1970s. In addition, substantial reductions in direct operating costs (15%) are achieved and reflected in fare reductions of 8%. Small--16-passenger--vans are operated in relatively low-density, short-distance markets (e.g., Stockton-Fresno). A combination of technical vehicle improvements, operational efficiencies, and government financial assistance programs* lead to fares for the small-van services that are not higher than would be the case for conventional 40-passenger buses.

Autos. Autos are smaller and more fuel-efficient in intercity travel. On the one hand, this leads to lower perceived costs of auto travel; on the other hand, their size makes them relatively unattractive for long-distance trips by families.

Access/Egress Systems. Improvements are characterized by a wide variety of services offered by individual entrepreneurs such as jitney services and off-airport parking and access. For the traveler, typical savings in access/egress time and cost are in the range of 10%.

Patronage

A summary of traveler responses to the transportation innovations of Scenario II is given in Table 10. The basis of comparison is Reference Case II.**

In general, traffic levels are greater for Scenario II than its reference case. Particularly attractive to passengers are:

- The short-runway aircraft service and improved passenger train service in corridors.
- Commuter air service and improved bus service (including passenger vans) in short-distance noncorridor markets.

In the paragraphs that follow, selected case studies of these and other transportation service innovations of Scenario II are described.

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*Subsidies exceed 10% of operating costs.

**Reference Case II includes pertinent information on population, personal income, fuel prices, etc., from Background Scenario II. However, as indicated in Appendix A, the reference case includes only modest changes in transportation service characteristics from those of the 1970s.

Table 10

SUMMARY PATRONAGE RESULTS FOR SCENARIO II
(Compared with Reference Case II)

Mode	High-Density Travel Corridors[a]	Large City-Pairs[b]	Smaller and/or Shorter Distance City-Pairs[c]
Air	Short-runway aircraft service (and attendant decreases in traveler access time and cost) increases traffic by a factor of 2 or 3. Market share doubles.	Small reductions in air fares lead to small increases in traffic (10%).	Commuter air services significantly increase traffic (factor of 3 to 4).
Rail	Significant increases in travel result from improved services (multiples of 2 to over 7). Market shares increase by 10 percentage points.	Widespread discontinuances of service cause patronage decreases. Affected traffic volume is small.	Small volumes of traffic are lost via discontinuances.
Bus	Traffic levels essentially unchanged (service improvements countered by improvements in other modes).	Traffic up by a factor of 2 in response to wider, more comfortable, buses. Market share does not exceed 10%.	Traffic up by a factor of 2; more in the case of small-van service. Market shares of 10% to 20% (vs 10% or less in reference case).
Auto	Decline in volume and market share, relative to reference case, because other modes have improved. Auto slips from majority to plurality of travel.	Modest (10%) increases in traffic due to fuel-efficient vehicles.	Modest (10%) increases in traffic.
Total Traffic	Increases of 30% to 60%.	Increases of 10% to 15%.	Increases of 30% to 100%.

a. Northeast Corridor (Boston-Washington), Chicago-St Louis, and Seattle-Portland.
b. Los Angeles-Washington, D.C., Boston-Denver; Los Angeles-Dallas/Fort Worth; and Atlanta-Detroit.
c. Detroit-Traverse City, Kansas City-Oklahoma City, Stockton-Fresno, and Denver-Billings.

Corridor Service, Chicago-St. Louis. The city-pair of Chicago-St. Louis is reasonably typical of corridor service in Scenario II. Data for this case are given in Table 11.

Short-runway aircraft service reduces the time and cost of air travel. Improved rail service with short trains substantially lowers the time of rail travel, but increases rail fares. Bus service is somewhat improved due to access savings and a fare reduction. Auto costs reflect savings due to lower fuel consumption.

The net effect of these changes on patronage is to increase market shares and traffic volumes for air rail. Total travel also increases (relative to the reference case) because of transportation service improvements.

Long-Distance Markets, Atlanta-Detroit. The city-pair of Atlanta-Detroit illustrates the changes that occur in long-haul (over 500 miles) passenger service in Scenario II.

As shown in Table 12, air service improves via small fare reductions--made possible by savings in aircraft operating costs--and improved access/egress. Similar kinds of improvements occur for bus service. Also, bus service is viewed more favorably by travelers because seats are wider. Auto fuel costs are down, but vehicles are smaller and rather uncomfortable for intercity travel.

The effect of the transportation innovations is to increase travel for each of the modes, with only slight changes in market shares.

Short-Distance Travel, Stockton-Fresno. Transportation service improvements for Stockton-Fresno in Scenario II include:

- The introduction of low-fare commuter air service* and airport access improvements.
- A new passenger-van bus service with high frequency of service.
- Fuel-efficient automoibles.

Data on these improvements are provided in Table 13.

The effect of the improvements is to increase traffic for each mode. It is noteworthy that improvements to air and bus reduce the market share for auto. However, the amount of auto travel increases.

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*In this case, commuter air service replaces service by an intrastate airline.

Table 11

DEMAND ANALYSIS--SCENARIO II
Chicago-St. Louis

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--Short-Runway Aircraft	1.9 (2.8)	$35.40[b] (38.60)	25 (31)
Rail--Short Train IPT	3.6 (6.1)	28.90 (16.40)	18 (3)
Bus--Wider Seats, Lower Fares	7.6 (7.7)	10.90 (11.90)	10 (10)
Auto--Improved Fuel Economy and Trip Pooling	4.8 (4.8)	7.10 (10.00)	

	Scenario II	Reference Case II	Early 1970s
Patronage			
Total Annual Passengers (millions)	3.5	2.2	1.6
Air	1.8	0.9	0.5
Rail	0.5	0.1	0.1
Bus	0.3	0.3	0.2
Auto	0.9	0.9	0.8
Market Shares (% of passenger trips)			
Air	52%	39%	34%
Rail	14	3	3
Bus	9	15	11
Auto	25	42	53

a. Values in parentheses are for Reference Case II.
b. Savings in access/egress cost.

Table 12

DEMAND ANALYSIS--SCENARIO II
Atlanta-Detroit

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--Lower Cost	3.4 (3.6)	$60.60 (63.30)	22 (22)
Bus--Wider Seats and Lower Fares	15.2 (15.3)	26.40 (28.40)	8 (5)
Auto--Improved Fuel Economy	14.2 (14.2)	18.40 (22.70)	
	Scenario II	**Reference Case II**	**Early 1970s**
Patronage			
Total Annual Passengers (thousands)	412	358	107
Air	338	300	133
Bus	24	12	4
Auto	50	46	33
Market Shares (% of passenger trips)			
Air	82%	84%	78%
Bus	6	3	3
Auto	12	13	19

a. Values in parentheses are for Reference Case II.

Table 13

DEMAND ANALYSIS--SCENARIO II
Stockton-Fresno, California

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--Commuter Service	1.6 (1.7)	$12.20 (13.60)	4 (2)
Bus--Passenger Van	3.1 (3.1)	5.80 (5.80)	15
Auto--Trip Pooling	2.4 (2.4)	3.25 (4.40)	

	Scenario II	Reference Case II	Early 1970s
Patronage			
Total Annual Passengers (thousands)	260	196	172
Air	26	6	4
Bus	47	18	9
Auto	187	172	159
Market Shares (% of passenger trips)			
Air	10%	3%	2%
Bus	18	9	5
Auto	72	88	93

a. Values in parentheses are for Reference Case II.

Revenues and Costs

Carrier revenue and cost estimates for Scenario II are compared with Reference Case II values in Table 14. It can be observed that IPT service in the corridors and discontinuance of rail service elsewhere has eliminated the deficits of conventional rail operations.

Table 14

REVENUES AND COSTS[a] SCENARIO II
(Thousands of 1974 Dollars)

Mode and Category		Northeast Corridor Scenario	Northeast Corridor Reference	Chicago-St. Louis Corridor Scenario	Chicago-St. Louis Corridor Reference	Seattle-Portland Corridor Scenario	Seattle-Portland Corridor Reference	Los Angeles-Wash.D.C. Scenario	Los Angeles-Wash.D.C. Reference	Boston-Denver Scenario	Boston-Denver Reference	Los Angeles-Dallas/Ft. Worth Scenario	Los Angeles-Dallas/Ft. Worth Reference
AIR	Gross Revenue[b]	$666,392	$288,299	$89,793	$34,234	$118,123	$38,532	$146,990	$142,250	$17,567	$17,399	$78,904	$76,265
	Operating Cost	644,855	273,999	87,278	32,536	114,815	36,621	139,699	135,194	16,695	16,536	74,990	72,482
	Net Revenue	21,537	14,300	2,514	1,698	3,307	1,911	7,291	7,056	871	863	3,914	3,783
RAIL	Gross Revenue	553,429	209,659	30,695	2,172	21,555	1,291	--	418	--	100	--	444
	Operating Cost	503,621	301,908	27,933	3,127	19,615	1,859	--	602	--	144	--	639
	Net Revenue (Deficit)	49,809[c]	(92,250)	2,763[c]	(955)	1,939[c]	(568)	--	(184)	--	(44)	--	(195)
BUS	Gross Revenue	85,792	95,406	5,871	7,021	4,474	5,343	1,458	773	712	378	3,947	2,124
	Operating Cost	79,786	88,728	5,460	6,529	4,161	4,969	1,356	719	662	352	3,671	1,975
	Net Revenue	6,005	6,678	411	491	313	374	102	54	50	26	276	149

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual routes.
b. Fare revenues less ticket tax of 8%.
c. It is assumed that this amout is used for guideway costs.

Table 14 (cont.)
REVENUES AND COSTS[a] SCENARIO II

Mode and Category		Detroit-Traverse City Scenario	Detroit-Traverse City Reference	Atlanta-Detroit Scenario	Atlanta-Detroit Reference	Kansas City-Oklahoma City Scenario	Kansas City-Oklahoma City Reference	Stockton-Fresno Scenario	Stockton-Fresno Reference	Denver-Billings Scenario	Denver-Billings Reference
AIR	Gross Revenue[b]	$2,032	$1,063	$16,881	$15,554	$9,451	$3,333	$216	$55	$4,357	$2,239
	Operating Cost	1,976	1,010	16,043	14,782	9,186	3,168	210	53	4,235	2,128
	Net Revenue	57	53	837	771	265	165	6	3	122	111
RAIL	Gross Revenue	--	--	--	13	--	31	--	--	--	--
	Operating Cost	--	--	--	19	--	45	--	--	--	--
	Net Revenue (Deficit)	--	--	--	(6)	--	(14)	--	--	--	--
BUS	Gross Revenue	214	124	523	284	465	297	199	73	221	145
	Operating Cost	199	115	486	264	432	276	219	68	206	135
	Net Revenue (Deficit)	15	9	37	20	33	21	(20)	5	15	10

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual routes.
b. Fare revenues less ticket tax of 8%.

Energy Consumption

Energy consumption data for Scenario II are given in Table 15. On a passenger-mile basis, consumption decreases relative to Reference Case II where conventional CTOL is the dominant mode; where short-runway or commuter aircraft services have been introduced, energy consumption generally increases. Similar effects occur for total energy consumption.

Table 15

ENERGY CONSUMPTION SCENARIO II

Geographic Setting	Per Passenger-Mile Consumption Relative to Reference Case[a]	Total Energy Consumption Relative to Reference Case[b]
Northeast Corridor	0.950	1.297
Chicago-St. Louis Corridor	1.089	1.600
Seattle-Portland Corridor	1.110	1.578
Los Angeles-Washington, D.C.	0.658	0.722
Boston-Denver	0.657	0.722
Los Angeles-Dallas/Ft. Worth	0.660	0.747
Detroit-Traverse City	1.015	1.441
Atlanta-Detroit	0.663	0.763
Kansas City-Oklahoma City	1.220	2.544
Stockton-Fresno	0.806	1.062
Denver-Billings	1.172	2.261

a. Btu per passenger-mile for scenario divided by Btu per passenger-mile for reference case.
b. Calculated Btu for scenario divided by calculated Btu for reference case.

Traffic Safety

Indices of traffic safety for Scenario II and its Reference Case are given in Table 16. In the scenario, the shift of market shares from auto to the relatively safer public modes counterbalances increases in traffic. Thus, calculated traveler fatalities are almost the same for Scenario II and its reference case.

Table 16

TRAFFIC SAFETY INDICES
SCENARIO II

Geographic Setting	Expected Number of Annual Traveler Fatalities[a] Scenario	Reference Case
Northeast Corridor	104	101
Chicago-St. Louis Corridor	10	11
Seattle-Portland Corridor	8	9
Los Angeles-Washington, D.C.	4	4
Boston-Denver	1	1
Los Angeles-Dallas/Ft. Worth	5	4
Atlanta-Detroit	1	1
Detroit-Traverse City	*	*
Kansas City-Oklahoma City	1	1
Stockton-Fresno	*	*
Denver-Billings	*	*

Note: Asterisk (*) denotes a value of less than 0.5.
a. Product of passenger-miles and accident rates (see Appendix A) by mode.

IV. TRANSPORTATION SCENARIO III

Introduction

The setting for Transportation Scenario III is characterized by consensus-oriented public decision-making, increasing problems and inefficiencies in both the public and private sector, and little innovation.

Generally, population and economic growth trends have not been conducive to growth in intercity travel. As shown in Table 17, population growth has been relatively low. More directly relevant is the sluggish growth in personal income and fuel prices which are five times those of 1974--an outcome of the 1990's petroleum energy crisis.

Overview of Transportation Innovations

Most of the changes in transportation hardware and operations that occur in Scenario III are an outgrowth of high fuel prices and fuel conservation measures. The changes are summarized below, and quantified in Appendix A.

Air Systems. Air transportation is provided by the National Air Service (a national corporation) with a now aging fleet of aircraft. High operating costs are reflected in high air fares. Public pressures cause flight frequencies to remain high in services between large cities; however, frequencies are reduced by 40% or more in low-density markets.

Rail Transportation. Rail service is provided by a national corporation. The corporation implements advanced Metroliner (improved passenger train) service in some high-density travel corridors and substantially upgrades service on other portions of the passenger rail network in response to increased patronage.

Bus Service. A large fleet of wide, comfortable buses provides service at increased frequencies, relative to the 1970s, in response to increased patronage. Substantial reductions in operating costs are achieved and reflected in fares. Moreover, bus operating costs are subsidized by the government as a fuel conservation measure.

Automobiles. Significant advances occur in fuel economy, with autos averaging 35 miles per gallon on intercity trips. However, the auto remains inefficient in fuel consumption relative to rail and bus transportation, and government restrictions are placed on auto travel, a 50% reduction in intercity vehicle trips.

Table 17

BACKGROUND SCENARIO III DATA

Corridor or City	Population (000) Year 2000	Population (000) Multiple of 1971	Total Personal Income (millions of 1967 dollars) Year 2000	Total Personal Income (millions of 1967 dollars) Multiple of 1971
Northeast Corridor	42,684	1.3	$175,690	1.2
Chicago-St. Louis Corridor	12,160	1.3	49,860	1.2
Seattle-Portland Corridor	3,638	1.3	13,735	1.3
Los Angeles	9,116	1.3	37,838	1.2
Washington, D.C.	5,190	1.8	21,486	1.6
Boston	4,996	1.3	20,031	1.3
Denver	1,981	1.6	7,278	1.4
Dallas/Ft. Worth	3,590	1.5	13,103	1.5
Traverse City	63	1.3	134	1.2
Detroit	5,323	1.3	21,706	1.2
Atlanta	2,465	1.7	9,118	1.6
Kansas City	1,793	1.4	6,788	1.3
Oklahoma City	1,028	1.6	3,483	1.5
Stockton	334	1.1	1,259	1.1
Fresno	455	1.1	1,591	1.0
Billings	102	1.1	339	1.1

Fuel price as a multiple of 1974 price = 5.00
Labor rates as a multiple of 1974 rates = 0.92
Prime interest rate (vs 8% in 1974) = 8%

Access/Egress Systems. Access to intercity terminals is more costly and time-consuming because construction of facilities lags and congestion increases. Twenty to twenty-five percent increases in cost and time for the access/egress portion of the traveler's journey are typical.

Patronage

A summary of traveler responses to the changes in transportation for Scenario III is given in Table 18. The basis for comparison is Reference Case III.

As indicated in Table 18, some new travel patterns emerge in response to high fuel prices and restricted auto use:

- In those high-density travel corridors where improved passenger train service is offered, the rail mode is the dominant mode of travel (50% or higher market-share of total travel).

- Long-distance travel declines, with air remaining the dominant mode.

- Bus travel is the dominant or principal mode for noncorridor trips of less than 500 miles.

In the paragraphs that follow, selected case studies for Scenario III are described.

Corridor Travel, New York City-Boston. Transportation service characteristics for Scenario III and patronage are shown in Table 19 for New York City-Boston.

The cost and time of air travel increases, as does the cost of rail travel. However, improved train service substantially reduces rail travel time. Bus travel time increases a bit because of access problems, but lower fares reduce travel costs.

The effect of these changes is to reduce air travel but increase rail and bus travel. Because its use is restricted, the auto market-share and travel levels are reduced.

Long-Distance Travel, Los Angeles-Dallas/Ft. Worth. Long-distance travel in Scenario III decreases because improved bus service and higher rail frequencies do not adequately compensate for increases in the cost and time of air travel.* These effects are shown in Table 20 for Los Angeles-Dallas/Ft. Worth.

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*Increases in travel time for air trips results from degraded access/egress service.

Table 18

SUMMARY PATRONAGE FOR SCENARIO III
(Compared with Reference Case III)

Mode	High-Density Travel Corridors[a]	Large City-Pairs[b]	Smaller and/or Shorter Distance City-Pairs[c]
Air	Combination of high air fares and competition from improved rail reduce traffic levels by a factor of 2.	High fares cause 20% decrease in traffic.	Combination of high fares and reduced flight frequencies cause 60% decrease in traffic.
Rail	Improved rail service captures about 50% of total travel in markets where it is provided.	Traffic triples in response to improved service. Market-shares remain at less than 3%.	Where service is offered, traffic increases are very large (rail benefits from degraded air and auto service).
Bus	20% to 30% increases in traffic because of lower fares.	Traffic more than doubles in response to low fares.	Low cost bus service (in combination with poor air and auto service) captures 50% of the total travel market.
Auto	Traffic reduced by one-half due to restrictions on use. (Traffic levels are one-sixth of those of the early 1970s.)	Traffic reduced by one-half due to restrictions on use. (Traffic levels are one-fifth those of the early 1970s.)	Traffic reduced by one-half due to restrictions on use. (Traffic levels are one-fifth those of the early 1970s.)
Total Traffic	No change from reference case where improved rail service is provided. Otherwise 20% decrease in traffic.	10% to 20% decrease.	20% to 30% decrease.

a. Northeast Corridor (Boston-Washington), Chicago-St. Louis, and Seattle-Portland.
b. Los Angeles-Washington, Boston-Denver, Los Angeles-Dalls/Fort Worth, and Atlanta-Detroit.
c. Detroit-Traverse City, Kansas City-Oklahoma City, Stockton-Fresno, and Denver-Billings.

Table 19

DEMAND ANALYSIS---SCENARIO III
New York City-Boston

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--High Fares	3.1[b] (2.6)	$44.25 (30.30)	41 (41)
Rail--IPT	3.6[b] (5.6)	24.80 (16.20)	36 (8)
Bus--Low Cost	7.4[b] (7.1)	8.90 (11.10)	36 (32)
Auto--Restricted Use, Fuel-Efficient	5.0 (5.0)	10.20 (14.50)	

	Scenario III	Reference Case III	Early 1970s
Patronage			
Total Annual Passengers (millions)	1.9	1.9	2.4
Air	0.5	1.0	1.0
Rail	0.8	0.2	0.2
Bus	0.4	0.3	0.2
Auto	0.2	0.4	1.0
Market Shares (% of passenger trips)			
Air	25%	50%	40%
Rail	44	13	8
Bus	23	17	10
Auto	8	20	42

a. Values in parentheses are for Reference Case III.
b. Includes higher access/egress times due to congestion.

Table 20

DEMAND ANALYSIS--SCENARIO III
Los Angeles-Dallas/Ft. Worth

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--High Cost	5.7[b] (5.1)	$130.80 (114.90)	17 (17)
Rail--Improved Frequency	35.4[b] (35.2)	96.10 (94.80)	4 (2)
Bus--Lower Cost, Improved Service	29.6[b] (29.4)	42.00 (52.80)	8 (5)
Auto--Fuel-Efficient, Restricted Use	28.1 (28.1)	54.80 (84.30)	

	Scenario III	Reference Case III	Early 1970s
Patronage			
Total Annual Passengers (thousands)	441	515	412
Air	343	455	313
Rail	9	3	4
Bus	73	27	12
Auto	16	30	83
Market Shares (% of passenger trips)			
Air	78%	88%	76%
Rail	2	1	1
Bus	17	5	3
Auto	3	6	20

a. Values in parentheses are for Reference Case III.
b. Includes increased access times due to congestion.

Short-Distance Travel, Kansas City-Oklahoma City. Kansas City-Oklahoma City is reasonably typical of service changes and resulting patronage changes for noncorridor trips of under 500 miles in Scenario III. Table 21 shows data for the case.

Air service has been substantially degraded--costs and travel time increase and flight frequencies decrease. Rail service is marginally less attractive because access time and cost increase; however, increased frequency of rail travel more than compensates for the access problems. Subsidized bus service is provided at lower cost and higher frequency. Perceived cost of auto travel is much reduced by reason of fuel economy, but use of autos is restricted.

The result of these changes is a substantial increase in bus traffic levels and market share. Rail traffic also increases while air traffic drops by about 60%. Auto traffic is about one-third the level of the early 1970s.

Revenues and Costs

Revenue and cost data for Scenario III and its reference case are given in Table 22. Operating cost difficulties are apparent for the national air and rail corporations, except in the case of corridor rail services. Also indicated is the effect of government subsidies for bus operations.

Energy Consumption

One of the attractive features of Scenario III is a significant decrease in energy consumption, as shown in Table 23. In some instances, total consumption is down by over 50% relative to Reference Case III because of the shift from air and auto travel to rail and bus travel.

Traffic Safety

Table 24 provides indices of traffic safety for Scenario III and its reference case. While expected traveler fatalities were low in Reference Case III, they are still lower in Scenario III. The decreases are primarily the result of decreased auto travel.

Table 21

DEMAND ANALYSIS--SCENARIO III
Kansas City-Oklahoma City

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--High Cost, Poor Service	3.4[b] (2.9)	$58.80 (50.30)	4 (7)
Rail--Improved Frequency	8.0[b] (7.8)	22.40 (21.60)	4 (1)
Bus--Lower Fares	8.3[b] (8.1)	13.00 (15.60)	8 (5)
Auto--Fuel-Efficient, Restricted Use	7.2 (7.2)	15.80 (24.00)	

	Scenario III	Reference Case III	Early 1970s
Patronage			
Total Annual Passengers (thousands)	110	137	129
Air	25	70	42
Rail	15	2	1
Bus	50	22	8
Auto	20	43	78
Market Shares (% of passenger trips)			
Air	22%	51%	33%
Rail	13	1	1
Bus	46	16	6
Auto	19	32	60

a. Values in parentheses are for Reference Case III.
b. Includes access/egress congestion effects.

Table 22

REVENUES AND COSTS[a] SCENARIO III
(Thousands of 1974 Dollars)

Mode and Category		Northeast Corridor Scenario	Northeast Corridor Reference	Chicago-St. Louis Corridor Scenario	Chicago-St. Louis Corridor Reference	Seattle-Portland Corridor Scenario	Seattle-Portland Corridor Reference	Los Angeles-Wash.D.C. Scenario	Los Angeles-Wash.D.C. Reference	Boston-Denver Scenario	Boston-Denver Reference	Los Angeles-Dallas/Ft. Worth Scenario	Los Angeles-Dallas/Ft. Worth Reference
AIR	Gross Revenue[b]	$139,750	$206,836	$15,405	$22,952	$17,674	$21,497	$104,557	$112,891	$13,580	$14,421	$39,944	$45,069
	Operating Cost	138,889	196,577	15,310	21,813	17,565	20,431	103,913	107,291	13,496	13,706	39,698	42,833
	Net Revenues	861	10,259	95	1,138	109	1,066	644	5,599	84	715	246	2,235
RAIL	Gross Revenue	375,980	148,474	25,176	1,590	1,877	823	503	320	246	83	783	262
	Operating Cost	349,662	213,802	23,414	2,289	2,702	1,185	724	461	354	120	1,128	377
	Net Revenue (Deficit)	26,319[c]	(65,329)	1,762[c]	(699)	(826)	(362)	(221)	(141)	(108)	(37)	(345)	(115)
BUS	Gross Revenue	67,042	69,073	4,988	5,209	3,123	3,408	1,305	608	671	320	2,636	1,289
	Operating Cost	72,405	64,237	5,387	4,844	3,373	3,170	1,409	565	725	298	2,847	1,199
	Net Revenue (Deficit)	(5,363)	4,835	(399)	364	(250)	239	(104)	43	(54)	22	(211)	90

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual routes.
b. Fare revenues less ticket tax of 4%.
c. It is assumed that this amount is used for guideway costs and vehicle costs.

Table 22 (cont.)
REVENUES AND COSTS[a] SCENARIO III

Mode and Category		Detroit-Traverse City Scenario	Detroit-Traverse City Reference	Atlanta-Detroit Scenario	Atlanta-Detroit Reference	Kansas City-Oklahoma City Scenario	Kansas City-Oklahoma City Reference	Stockton-Fresno Scenario	Stockton-Fresno Reference	Denver-Billings Scenario	Denver-Billings Reference
AIR	Gross Revenue[b]	$347	$806	$10,793	$12,418	$1,209	$2,832	$ 35	$41	$1,030	$2,128
	Operating Cost	345	766	10,726	11,802	1,202	2,692	35	39	1,024	2,022
	Net Revenue	2	40	67	616	7	140	0	2	6	106
RAIL	Gross Revenue	--	--	37	11	277	29	--	--	--	--
	Operating Cost	--	--	53	16	399	42	--	--	--	--
	Net Revenue (Deficit)	--	--	(16)	(5)	(122)	(13)	--	--	--	--
BUS	Gross Revenue	183	107	455	238	477	283	101	60	284	149
	Operating Cost	198	100	491	221	515	263	109	56	307	139
	Net Revenue (Deficit)	(15)	7	36	17	(38)	20	(8)	4	(23)	10

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual routes.
b. Fare revenues less ticket tax of 4%.

Table 23

ENERGY CONSUMPTION
SCENARIO III

Geographic Setting	Per Passenger Mile Consumption Relative to Reference Case[a]	Total Energy Consumption Relative to Reference Case[b]
Northeast Corridor	0.556	0.593
Chicago-St. Louis Corridor	0.539	0.590
Seattle-Portland Corridor	0.715	0.609
Los Angeles-Washington, D.C.	0.975	0.821
Boston-Denver	0.911	0.832
Los Angeles-Dallas/Ft. Worth	0.876	0.764
Detroit-Traverse City	0.537	0.414
Atlanta-Detroit	0.902	0.722
Kansas City-Oklahoma City	0.546	0.456
Stockton-Fresno	0.526	0.417
Denver-Billings	0.626	0.454

a. Btu per passenger-mile for scenario divided by Btu per passenger-mile for reference case.
b. Calculated Btu for scenario divided by calculated Btu for reference case.

Table 24

TRAFFIC SAFETY INDICES
SCENARIO III

Geographic Setting	Expected Number of Annual Traveler Fatalities[a] Scenario	Reference Case
Northeast Corridor	21	38
Chicago-St. Louis Corridor	2	4
Seattle-Portland Corridor	1	2
Los Angeles-Washington, D.C.	2	2
Boston-Denver	*	*
Los Angeles-Dallas/Ft. Worth	1	1
Atlanta-Detroit	*	*
Detroit-Traverse City	*	*
Kansas City-Oklahoma City	*	*
Stockton-Fresno	*	*
Denver-Billings	*	*

Note: Asterisk (*) denotes a value of less than 0.5.

a. Product of passenger-miles and accident rates (see Appendix A) by mode.

V. TRANSPORTATION SCENARIO IV

Introduction

The setting for Transportation Scenario IV is characterized by a strong government focusing its programs on achieving a variety of social welfare goals. The intercity transportation system in operation in the year 2000 is oriented toward helping to achieve these goals. Centralized governmental actions concentrate on producing efficient transportation services by reducing uneconomic competition within and among modes.

The effects of population and economic trends on intercity traffic levels are mixed. Population growth has been high but, as shown on Table 25, personal income growth has proceeded at a somewhat slower pace. Measured on a per capita basis in constant dollars, personal income is lower in the year 2000 than it was in the 1970s. Also, fuel prices are triple those of the 1970s. On the other hand, wage rates for transportation labor are low, as is the prime interest rate.

Overview of Transportation Innovations

Intercity transportation services provided by air, fixed guideway, and bus systems are all significantly improved by the year 2000 and each plays an important role in the integrated multimodal transportation system. Service characteristics for these modes are among those quantified in Appendix A.

Air Transportation. Aircraft serving "trunk," long-haul, routes are large (averaging over 250 seats) and are designed for fuel-efficiency and other savings in direct operating costs. Complementing the trunk portion of the air system is a very active "spoke" short-haul network. A variety of aircraft sizes are employed in the short-haul system to achieve both high flight frequencies attractive to travelers and high load factors. Fares for the short-haul system serving small cities are low, owing to advances in aircraft technology and an efficient operating system. It is government policy to keep fares low in the interest of achieving decentralization of population and economic activity.

Air traffic control system improvements have reduced aircraft block times by 6% relative to the early 1970s.

Fixed Guideway Systems. Tracked levitated vehicle systems (TLV) are installed in high-density travel corridors using equipment and methods that substantially reduced the cost of guideway construction. Passenger travel times are very low, given the systems. block speed of over 300 miles per hour in city-center service. Costs of investment in guideways are recovered through fares. Because patronage is high, this portion of the fare does not exceed 50%. In very dense markets, such as the

Table 25

BACKGROUND SCENARIO IV DATA

Corridor or City	Population (000) Year 2000	Population (000) Multiple of 1971	Total Personal Income (millions of 1967 dollars) Year 2000	Total Personal Income (millions of 1967 dollars) Multiple of 1971
Northeast Corridor	49,000	1.5	$171,802	1.2
Chicago-St. Louis Corridor	14,065	1.5	49,428	1.2
Seattle-Portland Corridor	4,653	1.6	15,121	1.4
Los Angeles	12,590	1.8	45,189	1.5
Washington, D.C.	5,003	1.7	17,455	1.3
Boston	5,873	1.6	19,106	1.2
Denver	2,198	1.7	6,508	1.3
Dallas/Ft. Worth	4,540	1.9	13,965	1.6
Traverse City	76	1.5	136	1.2
Detroit	6,428	1.5	21,988	1.2
Atlanta	2,693	1.9	8,546	1.5
Kansas City	2,135	1.7	7,743	1.5
Oklahoma City	1,072	1.6	3,627	1.6
Stockton	399	1.3	1,253	1.1
Fresno	380	1.4	1,719	1.1
Billings	109	1.2	305	1.0

Fuel price as a multiple of 1974 price = 3.17
Labor rates as a multiple of 1974 rates = 0.65
Prime interest rate (vs 8% in 1974) = 7%

Northeast corridor, guidway recovery costs are only 30% of total TLV operating costs, allowing TLV fares to be much lower than air fares.

Conventional rail service is discontinued in many long-distance (over 500-mile) markets, but the service is selectively introduced elsewhere. Improved frequencies and other service amenities are provided.

Bus Service. Comfortable widebody buses are permitted to travel at speeds of up to 75 miles per hour on dedicated highway lanes—in contrast to the automobile speed limit of 55 miles per hour. Vehicle and operating system improvements allow for some reductions in fares. Also, fares are subsidized in some instances to encourage bus rather than auto travel as a fuel conservation measure.

Access/Egress Systems. Access to intercity terminals is much improved over that of the 1970s as the result of fixed guideway and bus transit. Reductions in traveler cost and time for access and egress are typically on the order of 10% to 20%.

Patronage

A summary of traveler responses to the transportation innovations of Scenario IV is set forth in Table 26. The basis of comparison is Reference Case IV.

In high-density travel corridors, the tracked levitated vehicle systems are heavily patronized. The TLV has both stimulated total travel and become the dominant mode. Improved air and bus service in other geographic settings has also stimulated total travel, particularly in the case of smaller city-pairs.

In the paragraphs that follow, selected case studies of transportation service innovations are described.

TLV, New York City-Washington, D.C. Traveler response to the introduction of TLV service in the Northeast Corridor is overwhelming, as evidenced by the data in Table 27 for New York City-Washington, D.C. Total trip time for TLV is more than one hour less than that for air. It is this feature, combined with a government action of reducing air flights at the time of TLV introduction, that attracted business travelers to TLV. Their patronage, alone, was sufficient to reduce TLV fares below those for air, while still recovering full costs of TLV guideway investment and operating costs. Total patronage including pleasure travel, is so high in the corridor that TLV fares are now about the same as prior Metroliner fares. Train frequencies are very high, averaging one every 20 minutes.

Table 26

SUMMARY PATRONAGE RESULTS FOR SCENARIO IV
(Compared with Reference Case IV)

Mode	High-Density Travel Corridors[a]	Large City-Pairs[b]	Smaller and/or Shorter Distance City-Pairs[c]
Air	Traffic levels fall 50% to 60% because of reduced frequencies and TLV competition.	Improved service causes 20% to 30% increases in travel (lower fares, higher speed, better access).	Small aircraft services double air passenger volumes.
Fixed Guideway	TLVs capture 60% of total travel. (Trips are much faster and generally cheaper than air.)	Widespread discontinuance of rail service.	Service improvements and introductions of service lead to rail market-shares of 3% to 10% where service is provided.
Bus	Traffic increases 30% to 40% (low cost, high-speed service).	Traffic triples in response to low cost, high-speed service. Market-shares of 10% of total travel are typical.	Traffic triples in response to low cost, high-speed service. Market-shares of 25% are typical.
Auto	Traffic decreases 10% to 20%. (Traffic levels are 60% of those in early 1970s.)	Traffic increases of 10% to 20% are related to fuel-efficient autos. (Traffic levels are only 70% of those in early 1970s.)	Traffic decreases 10%.
Total Traffic	Total travel doubles, primarily because TLV service is offered.	Traffic increases 30%.	Traffic increases by 60% or more.

a. Northeast Corridor (Boston-Washington), Chicago-St. Louis, and Seattle-Portland.
b. Los Angeles-Washington, Boston-Denver, Los Angeles-Dallas/Fort Worth, and Atlanta-Detroit.
c. Detroit-Traverse City, Kansas City-Oklahoma City, Stockton-Fresno, and Denver-Billings.

Table 27

DEMAND ANALYSIS--SCENARIO IV
New York City-Washington, D.C.

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--Reduced Frequency	2.7 (2.9)	\$31.05 (31.60)	25 (49)
Rail--TLV	1.6 (4.3)	17.15 (17.30)	72 (25)
Bus (75-mph speed limit)	5.0 (6.3)	8.80 (9.50)	55 (55)
Auto--Improved Fuel Economy	5.1 (5.1)	10.15 (11.30)	

	Scenario IV	Reference Case IV	Early 1970s
Patronage			
Total Annual Passengers (millions)	8.6	2.8	2.4
Air	0.4	0.9	0.7
TLV/Rail	7.1	0.8	0.6
Bus	0.7	0.6	0.3
Auto	0.4	0.5	018
Market Shares (% of passenger trips)			
Air	5%	32%	30%
TLV/Rail	83	30	25
Bus	8	20	13
Auto	4	18	32

a. Values in parentheses are for Reference Case IV.

Air travel falls to the point where it is no longer necessary to enforce a flight reduction policy; to maintain load factors, airlines must reduce frequency in the face of TLV competition.

The introduction of TLV, and its stimulation of travel, causes total traffic between Washington, D.C., and New York City to nearly reach levels forecast in the late 1960s. However, the mix of traffic by mode is much different than was then forseen.

Improved Air (and Bus) Service, Los Angeles-Washington, D.C. The effects of the several changes that have occurred in long-distance travel are demonstrated in Table 28 for Los Angeles-Washington, D.C. The changes include:

- Improved access/egress for air and bus.
- Small (6%) reductions in air flight times due to air traffic control improvements.
- Lower air fares resulting from lower aircraft operating costs.
- Increased flight frequencies in step with increased air travel.
- Reduced trip times for bus, given the 75 mile-per-hour speed limit, and reduced bus fares because operating costs are reduced.
- Discontinuance of rail service.
- Substantial reductions in the perceived cost of auto travel (versus the reference case) because fuel consumption is reduced.

The principal net effect of these changes is to increase air travel.

Denver-Billings. Service by all modes generally improves in Scenario IV for relatively low-density markets of under 500 miles. The Denver-Billings city-pair is an example as shown in Table 29. Air fares are reduced and flight frequencies increase. Owing to the new "spoke" nature of air service between the cities (all flights are nonstop), the route is now served by 60-seat aircraft to maintain an average load factor of 60%.

Rail service is introduced between Denver and Billings as a part of the expanded AMTRAK network in the western United States. It meets with some success--capturing 3% of the total travel market and contributing to a decline in auto travel.

Table 28

DEMAND ANALYSIS--SCENARIO IV
Los Angeles-Washington, D.C.

	Travel Time in Hours: Access	Travel Time in Hours: Total	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]				
Air--Reduced Cost, Good Access	2.1 (2.6)	6.8 (7.6)	$150.80 (151.50)	34 (29)
Bus--High Speed (65-mph average), Low Cost	1.1 (1.2)	41.8 (54.3)	69.60 (78.00)	8 (5)
Rail	---not served by rail in scenario---	(56.8)	(130)	(3)
Auto--Fuel-Efficient		53.0 (53.0)	84.80 (114)	

	Scenario IV	Reference Case IV	Early 1970s
Patronage			
Total Annual Passengers (thousands)	932	715	432
Air	895	694	410
Rail	0	2	1
Bus	24	8	3
Auto	13	11	18
Market Shares (% of Passenger trips)			
Air	96%	97%	95%
Rail	0	--	--
Bus	3	1	1
Auto	1	2	4

a. Values in parentheses are for Reference Case IV.

Table 29

DEMAND ANALYSIS--SCENARIO IV
Denver-Billings

	Travel Time Including Access (hours)	Total Per Passenger Travel Cost	Daily Frequency of Service
Service[a]			
Air--Small Aircraft Service	2.3 (2.6)	$39 (48)	10 (5)
Rail--New Service	---not served by rail in reference case---		
Bus--High Speed Low Fares	8.8 (11.5)	13 (17)	8 (5)
Auto--Fuel-Efficient	10.6 (10.6)	17 (23)	

	Scenario IV	Reference Case IV	Early 1970s
Patronage			
Total Annual Passengers (thousands)	129	59	67
Air	91	38	34
Rail	4	0	0
Bus	22	8	4
Auto	12	13	29
Market Shares (% of passenger trips)			
Air	71%	64%	51%
Rail	3	0	0
Bus	17	13	6
Auto	9	23	43

a. Values in parentheses are for Reference Case IV.

Both the time and cost of bus travel have improved substantially and patronage has increased. Government subsidies of bus fares are 20%.

About 10% of total travelers continue to drive by auto between Denver and Billings. This is a far lower percentage than would have been the case without improvements to the other modes. While the volume of auto traffic in Scenario IV is not reduced much from Reference Case IV, it is greatly reduced from volume levels of the early 1970s.

Revenues and Operating Costs

Estimates of carrier revenues and costs for Scenario IV are given in Table 30. Noteworthy are the break-even status of TLV (full cost recovery fares) and the shift in subsidy requirements from rail to bus.

Energy Consumption

Data on energy consumption for Scenario IV are shown in Table 31. Consumption is down substantially--both per passenger-mile and in total--where improved conventional aircraft represents the dominant mode (e.g., Los Angeles-Washington, D.C.). For other noncorridor cities, increased travel overcomes savings per passenger-mile and total consumption increases. In the corridors, the effect of TLV energy consumption dominates. The estimated energy consumption for TLV is less than that of improved aircraft but more than that of other (improved) modes per passenger-mile. In terms of total energy consumption in the corridors, traffic has increased to the extent that energy consumption approximately doubles.

Traffic Safety

Data on expected traveler fatalities for Scenario IV and its reference case are shown in Table 32. The shift (on a market-share basis) from auto travel to the safer common carrier modes in Scenario IV generally counterbalances increased traffic levels. Thus, calculated fatalities for the scenario are about the same as those of its reference case.

Table 30

REVENUES AND COSTS[a] SCENARIO IV
(Thousands of 1974 Dollars)

Mode and Category		Northeast Corridor		Chicago-St. Louis Corridor		Seattle-Portland Corridor		Los Angeles-Wash.D.C.		Boston-Denver		Los Angeles-Dallas/Ft. Worth	
		Scenario	Reference	Scenario	Reference	Scenario	Reference	Scenario	Reference	Scenario	Reference	Scenario	Reference
AIR	Gross Revenue[b]	$ 86,401	$190,687	$ 9,782	$22,706	$ 12,415	$25,354	$119,304	$98,287	$13,488	$11,939	$61,479	$52,266
	Operating Cost	82,115	181,229	9,297	21,580	11,799	24,097	113,386	93,412	12,819	11,347	58,429	49,673
	Net Revenue	4,285	9,458	485	1,126	616	1,258	5,917	4,875	669	592	3,049	2,592
RAIL	Gross Revenue	1,146,571	146,170	137,174	1,595	116,449	952	--	299	244	71	--	316
	Operating Cost	814,066	187,097	97,394	2,042	82,679	1,219	--	383	281	91	--	404
	Net Revenue (Deficit)	332,506[c]	(40,928)	39,781[c]	(447)	33,770[c]	(267)	--	(84)	(37)	(20)	--	(88)
BUS	Gross Revenue	78,602	70,092	6,729	5,370	4,937	3,864	1,575	590	737	286	4,101	1,592
	Operating Cost	73,100	65,186	6,258	4,994	4,591	3,593	1,465	549	685	266	3,814	1,481
	Net Revenue	5,502	4,906	471	376	346	270	110	41	52	20	287	111

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual routes.
b. Fare revenues less ticket tax of 8%.
c. It is assumed that this amount is used for guideway costs and vehicle costs.

Table 30 (cont.)
REVENUES AND COSTS[a] SCENARIO IV

Mode	Category	Detroit-Traverse City Scenario	Detroit-Traverse City Reference	Atlanta-Detroit Scenario	Atlanta-Detroit Reference	Kansas City-Oklahoma City Scenario	Kansas City-Oklahoma City Reference	Stockton-Fresno Scenario	Stockton-Fresno Reference	Denver-Billings Scenario	Denver-Billings Reference
AIR	Gross Revenue[b]	$1,393	$718	$12,012	$10,357	$3,735	$2,551	$129	$37	$2,869	$1,500
	Operating Cost	1,384	682	11,416	9,844	3,711	2,424	128	35	2,850	1,426
	Net Revenue	9	36	596	514	24	127	1	2	18	74
RAIL	Gross Revenue	--	--	--	9	261	26	81	--	78	--
	Operating Cost	--	--	--	12	300	33	93	--	90	--
	Net Revenue (Deficit)	--	--	--	(3)	(39)	(7)	(12)	--	(12)	--
BUS	Gross Revenue	222	96	536	211	587	263	132	55	241	112
	Operating Cost	244	89	498	196	646	245	145	51	265	104
	Net Revenue (Deficit)	(22)	7	38	15	(59)	18	(13)	4	(24)	8

a. Calculated by applying assumed industry averages for operating costs as a percent of revenues (see Appendix A) to individual routes
b. Fare revenues less ticket tax of 8%.

Table 31

ENERGY CONSUMPTION
SCENARIO IV

Geographic Setting	Per Passenger-Mile Consumption Relative to Reference Case[a]	Total Energy Consumption Relative to Reference Case[b]
Northeast Corridor	1.015	2.428
Chicago-St. Louis Corridor	0.822	1.649
Seattle-Portland Corridor	0.843	1.790
Los Angeles-Washington, D.C.	0.655	0.855
Boston-Denver	0.638	0.831
Los Angeles-Dallas/Ft. Worth	0.645	0.859
Detroit-Traverse City	0.962	1.568
Atlanta-Detroit	0.646	0.838
Kansas City-Oklahoma City	0.942	1.666
Stockton-Fresno	0.723	1.111
Denver-Billings	1.090	2.376

a. Btu per passenger-mile for scenario divided by Btu per passenger-mile for reference case.
b. Calculated Btu for scenario divided by calculated Btu for reference case.

Table 32

TRAFFIC SAFETY INDICES
SCENARIO IV

Geographic Setting	Expected Number of Annual Traveler Fatalities[a] Scenario	Reference Case
Northeast Corridor	59	54
Chicago-St. Louis Corridor	5	6
Seattle-Portland Corridor	5	4
Los Angeles-Washington, D.C.	3	3
Boston-Denver	3	*
Los Angeles-Dallas/Ft. Worth	3	2
Atlanta-Detroit	*	*
Detroit-Traverse City	*	*
Kansas City-Oklahoma City	*	*
Stockton-Fresno	*	*
Denver-Billings	*	*

Note: Asterisk (*) denotes a value of less than 0.5
a. Product of passenger-miles and accident rates (see Appendix A) by mode.

Appendix A

SUMMARY TRANSPORTATION MODE DESCRIPTIONS
(Numerical Data Reflecting Cost, Speed,
and Other Service Assumptions)

Table A-1

AIR SYSTEM CHARACTERISTICS

	Nominal Average Seats In Fleet	Target Load Factor	Average Cruise Speed[b]	Nominal Average Coach Fare (Gross) in Cents per Passenger-Mile[c] 300 Miles	1,500 Miles	Total Operating Cost as Percent of Gross Fare[d]	Energy Consumption (Btu/pass-mile)	Accidents, Fatality Rate per 10^8 Passenger-Miles
Scenario I[a]								
Improved CTOL	300	60%	550	15.6¢	8.6¢	84%	3,500	0.13
Corridor CTOL[d]	300	60	550	13.1	--	75	3,500	0.13
Giant-Jet	900	60	550	--	7.6	92	3,000	0.13
SST	300	60	1,350	--	$\boxed{11.3}$	90	$\boxed{6,000}$	0.13
Reference Aircraft	250	60	510	15.6	8.6	88	3,500	0.13
Scenario II								
Improved CTOL	250	60	510	12.5	6.7	88	2,300	0.13
Short-Runway Aircraft	150	60	510	$\boxed{13.0}$	--	90	$\boxed{4,500}$	0.13
Small Aircraft	20 to 100	60	510	$\boxed{9.5}$	--	90	4,000	0.13
Reference Aircraft	250	60	510	13.0	7.1	88	3,500	0.13
Scenario III								
Conventional Aircraft	250	60	510	16.9[e]	9.6[e]	95[e]	3,500	0.13
Reference Aircraft	250	60	510	14.6	8.6	88	3,500	0.13
Scenario IV								
Improved CTOL	250	60	510	11.5	6.7	88	2,300	0.13
Short-Haul Aircraft	20 to 80	60	510	$\boxed{9.4}$	--	92	4,000	0.13
Reference Aircraft	250	60	510	12.0	7.1	88	3,500	0.13
1974								
Comparison Aircraft	125	55	510	11.0	7.5	88	5,000	0.13

$\boxed{}$ Denotes significant technological breakthrough.

a. CTOL denotes conventional aircraft.
b. See Table A-1a following for Air Traffic Control Effect.
c. Note that gross fare includes an 8% tax in all cases except Scenario III.
d. Includes PSA-type service.
e. Gross fare includes a 4% tax.

Table A-2

EFFECTS OF AIR TRAFFIC CONTROL SYSTEM PERFORMANCE

	Average "Fixed" Portion of Aircraft Flight Time[a] (hours)	Reduction in "Variable" En Route Time via Decreased Delays[a] (percent)
Scenario I	0.38	4%
Scenario IV	0.38	6
Small Aircraft Service in Scenarios II and IV	0.20	0
All Other: Scenarios II and III, plus Reference Cases I to IV, and 1974	0.40	0

a. Analysis of airline flight times (*Official Airline Guide*, various issues, 1973) indicates that:

$$\text{Flight Time} = k + \frac{d}{s}$$

where

k = "fixed" portion

$\frac{d}{s}$ = variable portion; distance divided by average speed

Table A-3

INTERCITY RAIL AND OTHER FIXED GUIDEWAY CHARACTERISTICS

	Average Seats[a]	Target Load Factor	Block Speed (miles/hour)	Average Fare in Cents per Passenger-Mile	Operating Costs as Percent of Fare	Energy Consumption (Btu/pass-mile)	Accidents, Fatality Rate per 10^8 Passenger-Miles	Other Assumptions
Scenario I								
Improved Passenger Train (IPT)	350	60%	110	11.1¢[b]	91%[b]	700	0.10	Used for selected city-pairs in Scenario I as well as Reference Case I
Reference Train	150	50	57	6.4	144	1,200	0.10	
Scenario II								
Improved Passenger Train (IPT)	175	60	110	9.4[b]	91[b]	700	0.10	
Reference Train	150	50	57	5.4	144	1,200	0.10	
Scenario III								
Improved Passenger Train (IPT)	350	60	110	9.9[b]	93[b]	700	0.10	Used for some city-pairs in Scenario III as well as Reference Case III
Reference Train	150	50	57	5.9	144	1,200	0.10	
Scenario IV								
Tracked Levitated Vehicle System	350	60	315	$\boxed{7.9}$[c]	$\boxed{71}$[c]	2,100	0.10	
Improved AMTRAK	200	60	65	4.1	115	1,000	0.10	
Reference Train	150	50	57	5.1	128	1,200	0.10	
1974								
Comparison Train	90	40	57	5.1	180	1,500	0.10	

☐ Denotes significant technological breakthrough.

a. Approximate.
b. Indicated values relate to full cost recovery fare policy and annual passenger level of 5 million. See Table A-4 following.
c. Indicated values relate to full cost recovery fare policy and annual passenger level of 40 million. See Table A-5 following.

Table A-4

IMPROVED PASSENGER TRAIN COST ASSUMPTIONS

Scenario	Traffic Density in Millions of Passenger-Miles per Mile	Possible Components of Fare[a] (cents per passenger-mile): Total Operating Cost[b]	Annual Return on Train Equipment	Annual Cost of Guideway Improvement[c]
I	5	10.1¢	0.6¢	0.4¢
	10	10.1	0.6	0.2
II	5	8.6	0.4	0.4
	10	8.6	0.4	0.2
	20	8.6	0.4	0.1
III	5	9.2	0.4	0.3
	10	9.2	0.4	0.2
	20	9.2	0.4	0.1

a. Values assume a 60% load factor.
b. Train crew labor constitutes a relatively high percentage of total operating cost (about 30%) on the assumption that work rules favorable to crewmen (mileage-based pay) will continue.
c. Assumes initial cost of guideway improvement in $172,000 per mile. Annual cost varies by scenario because of interest rate variations.

Table A-5

TRACKED LEVITATED VEHICLE SYSTEM
COST ASSUMPTIONS
(Scenario IV)

Traffic Density in Millions of Passenger-Miles per Mile	Possible Components of Fare[a] (cents per passenger-mile) Total Operating Cost[b]	Annual Return on Train Equipment	Annual Cost of Guideway[c]
5	6.8¢	0.3¢	18.0¢
10	6.0	0.2	9.0
20	5.6	0.2	4.5
40	5.4	0.2	2.3

a. Values assume a 60% passenger load factor.

b. Crew labor constitutes a low percentage of total operating cost (less than 3%) because of high-speed operation and the assumption that crewmen are not paid on a mileage basis.

c. Assumes initial cost of guideway is $5 million per mile, given breakthroughs in construction methods and costs. (Current estimate is $11 million.) Annual cost per mile of guideway is $900,000, based on Scenario IV interest rate and assumptions on economic lives of guideway components.

Table A-6

INTERCITY BUS CHARACTERISTICS

	Vehicle Width (inches)	Average Seats[a]	Target Load Factor	Block Speed (miles/hour)	Fare in Cents per Passenger-Mile	Operating Costs as Percent of Fare	Energy Consumption (Btu/pass-mile)	Accidents, Fatality Rate per 10^8 Passenger-Miles	Other Assumptions
Scenario I									
Fast, profitable bus	96	40	60	$\boxed{60}$	4.3	90%	900	0.10	Not all cost savings are reflected in fares
Reference bus	96	40	60	50	4.3	93	700	0.10	
Scenario II									
Improved cost performance bus	106	40	60	50	3.3	93	700	0.10	Comfortable bus, wide seats
Small van	<96	16	60	50	$\boxed{3.6}$	$\boxed{110}$	500	0.10	Government subsidies
Reference bus	96	40	60	50	3.6	93	700	0.10	
Scenario III									
Improved cost performance bus	102	40	60	50	$\boxed{2.9}$	108	700	0.10	Government subsidies
Reference bus	96	40	60	50	3.8	93	700	0.10	
Scenario IV									
Fast, cost-efficient bus	$\boxed{106}$	40	60	$\boxed{65}$	2.7	93	1,000	0.10	Comfortable bus, wide seats
Fast, efficient, subsidized bus	$\boxed{106}$	40	60	$\boxed{65}$	2.3	110	1,000	0.10	Government subsidies
Reference bus	96	40	60	50	3.0	93	700	0.10	
1974									
Comparison bus	96	40	50	50	4.1	95	800	0.10	

$\boxed{}$ Assumes significant technological, economic, or regulatory breakthrough.
a. Approximate.

Table A-7

AUTOMOBILE PERFORMANCE IN INTERCITY SERVICE

	Block Speed (miles/hour)	Perceived Cost per Vehicle-Mile (cents)	Energy Consumption: Average Miles per Gallon[a]	Energy Consumption: Btu per Passenger-Mile	Accidents Fatality Rate per 10^8 Passenger-Miles	Other Assumptions
Scenario I						
High-speed auto	57	8.9¢	20	2,400	1.7	
Electric-powered intercity auto	57	$\boxed{6.5}$	not applicable	$\boxed{1,700}$	1.0	Perceived cost includes 0.8¢ per mile for electrical pick-up equipment; 70% of vehicle trips assumed to use service where available.
Reference auto	50	8.9	20	2,400	1.5	
Scenario II						
Smaller, fuel-efficient auto	50	6.5	28	1,900	1.5	
Reference auto	50	7.1	20	2,400	1.5	
Scenario III						
Very fuel-efficient auto	50	8.9	$\boxed{35}$	1,375	1.5	Regulations curtail use.
Reference auto	50	13.7	20	2,400	1.5	
Scenario IV						
Smaller, fuel-efficient auto	50	7.2	30	1,600	1.5	
Reference auto	50	9.6	20	2,400	1.5	
1974						
Comparison auto	50	5.5	15	3,200	1.7	

$\boxed{\quad}$ Assumes significant technological breakthrough.

a. Approximate

Appendix B

DEMAND ANALYSIS METHODS

Appendix B

DEMAND ANALYSIS METHODS

Introduction

A multimodal intercity passenger demand model has been used in the study to prepare estimates of travel demand for the geographic settings of each transportation scenario and its reference case. This appendix provides a brief description of the model.

General Procedure

The basic demand analysis procedure is portrayed in the block diagram of Figure B-1. The procedure is separately applied to each corridor or city-pair that is examined.

In Block 1, a preliminary estimate of total future travel demand is calculated. The preliminary projection of total travel accounts for population and personal income changes, but does not consider changes in quality of transportation service that might affect total travel levels.

In Block 2, data on transportation service by mode--cost, time, and frequency of service--are used to develop mode split information (i.e., market shares). Two kinds of trip purpose are considered: business and nonbusiness travel. The procedure is to calculate "travel conductance" measures for each mode by trip purpose using cost, time, and frequency inputs. The calculated travel conductance values are then used to develop market shares.

The purpose of Block 3 is to estimate the degree to which total travel demand will change, given a change in the level of transportation service. If service is improved, it is expected that new travel will be induced (new travelers and/or more frequent trips), and total demand will increase. Conversely, if service is degraded, it is expected that some travel will be suppressed. The estimating procedure uses the travel conductance measures calculated in Block 3 and a set of "baseline" conductance values. The baseline conductance values are calculated as in Block 3, using some reference set of travel times, costs, and frequencies of service.

In Block 4, the results of prior calculations are combined to yield forecasts of travel demand by mode and trip purpose. These forecasts, in turn, are used to calculate such statistics as passenger-miles, fare revenues, and energy consumption.

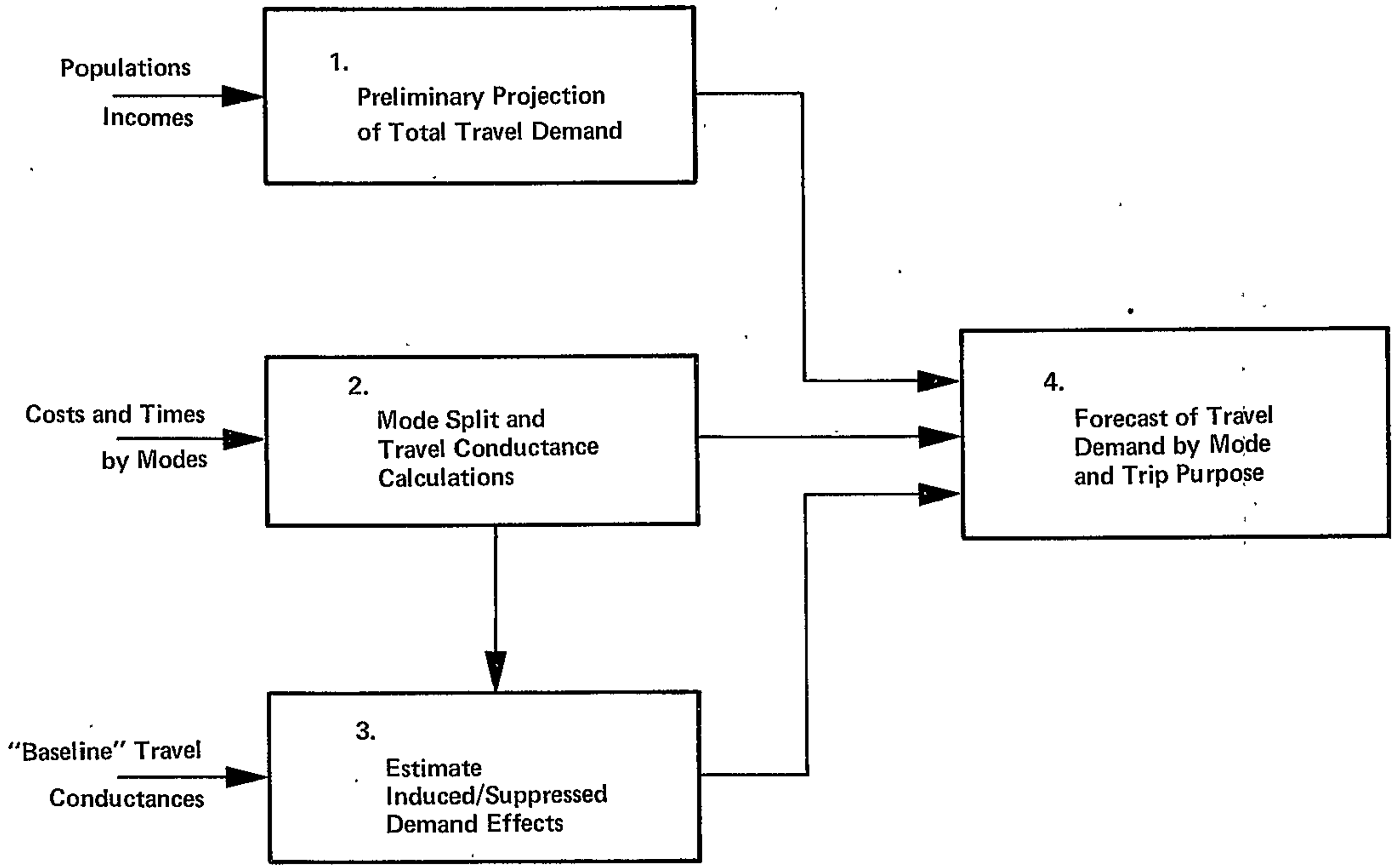

Figure B-1. TRAVEL DEMAND METHOD FOR A CITY-PAIR

Model Characteristics

Before the mathematical formulation of the demand procedure is described, some characteristics of the model and provisos regarding the values it produces are discussed.

Normative Travel Projections (Block 1). The model projects *changes* in travel at the city-pair level as a function of *changes* in populations and personal incomes. In the past, this approach has proved superior to one of estimating total travel from only demographic and economic data, because many other factors (e.g., home office/branch plant locations) influence travel levels for a city-pair. It must be recognized that the adopted approach to normative travel projections has limitations in a study such as this one where the scope includes potentially significant changes in the "other factors."

Mode Split (Block 2). The mode split model used in this study is one of several that were formulated, calibrated, and tested in studies related to the Northeast Corridor Transportation Project.[1,2,3] As a result of testing, the model emerged as superior to other candidates in replicating actual travel patterns in the Northeast Corridor and in many other geographic applications, as well.[3]

Two of the most important potential limitations of the mode split model, as applied in this study are:

1. Sufficient actual travel data do not exist to insure that the model is valid for all geographic cases considered. In particular, data for rail, bus, and auto travel are sparse for the smaller city-pairs* considered in the analysis.

2. Traveler perceptions of the relative importance of travel time, cost, and frequency of service are likely to vary among the scenarios examined. This would suggest that different mode split equations might be used for each scenario. However, modifications to the mode split model in response to scenario variations were generally not attempted in this analysis.

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*The Transportation Systems Center, Department of Transportation, provided much useful travel data for the larger city-pairs, based on an analysis of the 1972 National Transportation Survey.

Induced/Suppressed Travel (Block 3). It is clear that intercity travel levels are influenced by changes in the nature of available transportation services. However, it has proved difficult to isolate and quantify this relationship because of other influences on travel levels. (For this reason, many analyses essentially ignore possible induced/suppressed travel.) The approach used in this analysis was developed in prior studies,[4,5] and it appears to yield reasonable results--at least in the case of relatively small changes to transportation services. In the scenarios of this study, however, some of the postulated changes in transportation service are very large (e.g., introduction of tracked levitated vehicle systems), and it is not clear that the large amounts of induced/suppressed demand calculated by the model are reasonable.

Mathematical Formulation

The formula for calculating a preliminary projection of total travel demand for a city-pair (Block 1) is given in Table B-1. Necessary data on future populations and personal incomes are obtained from the study's background scenarios.

In Table B-2, the general formulation of the mode split/travel conductance calculations (Block 2) is given. The formulation accounts for:

- Total travel time, including access, egress, terminal, and line-haul portions of a trip
- Total travel cost
- Frequency of service (For automobile, the formulation implies an infinite frequency of service)

These values are developed for each mode in each scenario using the data and assumptions on transportation service of Appendix A.

The parameters used in the travel conductance formulas are given in Table B-3. In general, the parameter values used in the applications of this study are those that were obtained when the model was calibrated (Part A of Table B-3). However, as shown in Part B of Table B-3, certain arbitrary changes were made to the a_0 parameters to account for selected service assumptions of the transportation scenarios.

The formula for calculating induced/suppressed travel demand effects (Block 3) is given in Table B-4. The calculated values of R_p (one value for business travel and one value for nonbusiness travel) are applied to the normative projections of travel (Block 1) in Block 4 of the demand analysis procedure.

Table B-1

PRELIMINARY PROJECTION OF TOTAL TRAVEL DEMAND

$$D_F = D_C \cdot \left[\frac{P_{aF} \cdot P_{bF} \cdot P_{nC}}{P_{aC} \cdot P_{bC} \cdot P_{nF}}\right] \cdot \left[\frac{1.77\ I_F - 203}{1.77\ I_C - 203}\right]$$

where

D_F = projected future total travel demand between two cities

D_C = current total travel demand

P_a, P_b = metropolitan area populations for city a and city b for current (C) and future (F) year

P_n = national population; current (C) and future (F)

I = per capita personal income of the two cities; current (C) and future (F)

Table B-2

MODAL SPLIT AND TRAVEL CONDUCTANCE

1. Travel conductance for the i^{th} mode:

$$w_i = a_o t^{a_1} c^{a_2} f'^{a_3}$$

where

t = door-to-door travel time, in hours

c = door-to-door travel cost, in constant dollars

f' = frequency labor (see below)

aj = calibrated parameters; one set for business travel, and one set for nonbusiness travel (see Table B-3)

2. Frequency factor:

$$f' = 1 - 3^{-kf}$$

where

f = daily departures, one-way

k = a calibrated parameter (see Table B-3)

3. Total travel conductance:

$$W = \sum_i w_i$$

4. Modal share:

$$S_i = \frac{w_i}{W}$$

Table B-3

TRAVEL CONDUCTANCE PARAMETERS

A. Calibrated Parameters

Travel Purpose	Mode	a_o	a_1	a_2	a_3	k
Business	Air	1.1232	-3.384	-0.483	2.279	0.12
	Rail	1.4813	-3.384	-0.483	2.279	0.12
	Bus	0.3767	-3.384	-0.483	2.279	0.12
	Automobile	1.0	-3.384	-0.483	0	0
Non-business	Air	0.7767	-1.5821	-1.5821	2.0462	0.18
	Rail	1.9881	-1.5821	-1.5821	2.0462	0.18
	Bus	1.3872	-1.5821	-1.5821	2.0462	0.18
	Automobile	1.0	-1.5821	-1.5821	0	0

B. Scenario Adjustments to a_o

Scenario	Mode	Nature of Adjustment	Rationale
I, II, and III	Rail, Improved Passenger Train	10% Increase	Service amenities
IV	Tracked Levitated Vehicle Systems ("Rail")	20% Increase	Comfortable, attractive service
II and IV	Bus	15% Increase	Wide seats plus service amenities
III	Bus	10% Increase	Service amenities
II and IV	Auto	10% Decrease	Small, uncomfortable vehicles
III	Auto	50% Decrease	Regulations curtail use

Table B-4

INDUCED/SUPPRESSED DEMAND

An adjustment factor, R_p, is calculated as:

$$R_p = \left(\frac{W_F}{W_N}\right)^{\beta}$$

where

W_F = travel conductance at forecast levels of transportation service (Block 2)

W_N = travel conductance at "baseline" levels of transportation service

β = 0.6

References

1. J. M. McLynn and R. H. Watkins. *Analysis and Calibration of a Modal Allocation Model.* Revised. Davidson, Talbird and McLynn, Inc., June 1967.

2. National Bureau of Standards. National Bureau of Standards Modeling for the NECTP. NECTP-213, 1969.

3. "A Comparative Evaluation of Intercity Modal-Split Models, in Travel Demand Forecasting," *Transportation Research Record 526.* 1974, pp. 83-92.

4. J. W. Billheimer. "Segmented, Multimodal, Intercity Passenger Demand Model," *Highway Research Record 392.* 1972, pp. 47-57.

5. *Michigan State Airport System Plan, Technical Report.* Stanford Research Institute, 1974.

Appendix C

PROJECTIONS OF POPULATION AND PER CAPITA INCOME TO THE YEAR 2000

Appendix C

PROJECTIONS OF POPULATION AND PER CAPITA INCOME TO THE YEAR 2000

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Introduction

This paper contains four alternative population and income projections to the year 2000, prepared for use in analyzing possible future forms of intercity transportation. The principal use for these projections was in the analysis of demand for alternative future intercity transportation technologies.

Population and income projections are presented for the nation as a whole and for a number of selected cities and corridors. The cities and corridors were selected based on the needs of the travel demand analysis.

The projections are based on adjustment and coordination of several previous projections, which are described below. The main data sources are two OBERS--Office of Business & Economics (OBE), U.S. Department of Commerce, and the Economic Research Service (ERS), U.S. Department of Agriculture--projections of economic activity in the U.S. for the years 1929 to 2000. These two original projections are similar in their structure and assumptions; they basically differ only in their assumed projection of national population. The first of the two reports, referred to here as "OBERS 72," is based on the Series C population projection of the U.S. Census.[1] The second report, referred to here as "OBERS 74," is based on the lower Census Series E population projection.[2]

The population and income projections in these two OBERS reports were modified through a series of adjustment factors to be compatible with four different scenarios of the future, as reported in Part A of this volume. An effort was made to tie the adjustments to a second set of disaggregate population and income forecasts prepared by Alonso;[3] but since the degree of fine detail represented in the Alonso study was inconsistent with the rather gross adjustments required to match the four scenarios of this study, this extra refinement was omitted.

The report is organized in three principal sections. The next section briefly describes the history of the OBERS projections, the assumptions, and projection methodology. This section also presents the national population and economic totals upon which the disaggregate projections are based. The next section describes the basic features of the Alonso scheme for forecasting population and income by locality. In the final section, the analysis performed to adjust the OBERS projections to the four scenarios is detailed, and the quantitative results of the analysis are tabulated.

The OBERS Report

The OBERS report was prepared in response to a need for basic economic information by public agencies engaged in comprehensive planning for the use, management, and development of the nation's water and related resources. It is evident, however, that it is being used for a variety of other purposes, both public and private.

The report represents the major output of a program of economic measurement, analysis, and projection conducted by the Bureau of Economic Analysis (BEA), formerly the Office of Business Economics (OBE), U.S. Department of Commerce, and the Economic Research Service (ERS), U.S. Department of Agriculture with assistance from the Forest Service. The work has been carried out under a cooperative agreement with the Water Resources Council (WRC). The program was initiated in 1964 by members of the (then) *ad hoc* WRC. Upon permanent establishment of the WRC by the Water Resources Planning Act of 1965, the program became an integral part of the comprehensive water resources planning program and the periodic national assessments of water and related land resources.

Several years ago the program acquired the acronym of OBERS, signifying a unified effort by OBE and ERS, in which an integrated set of projections was developed under a common set of assumptions and procedures. Although the OBE has been renamed the BEA* and will be so identified in this report, the widespread acceptance of the term OBERS has led to its continued use as a descriptive title for the projection program.

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*On January 1, 1972, as a step toward the President's proposed Department of Economic Affairs, the Office of Business Economics and the Bureau of the Census were merged to form the Social and Economic Statistics Administration (SESA). In that reorganization, the OBE was renamed the Bureau of Economic Analysis.

The objectives of the OBERS program are the development and maintenance of (1) a regional economic information system with provisions for rapid and flexible data retrieval; (2) near-term (1980-1990), mid-term (2000), and far-term (2020) projections of population, economic activity, and land use for the nation and its geographic subdivisions; and (3) special analytical systems designed for use in water resources and other public investment planning.

The General Assumptions. The OBERS projections are based on long-run or secular trends and ignore the cyclical fluctuations which characterize the short-run path of the economy. The general assumptions that underlie the projections are as follows:

1. Growth of population will be conditioned by:

   a. Decline of fertility rate from rates of 1962 to 1965 following Census projections Series C according to OBERS 72.

   b. A fertility rate which represents "replacement level fertility" following Census projections Series E according to OBERS 74.

   (Further discussion of the different population projections is provided later.)

2. Nationally, reasonably full employment represented by a 4% unemployment rate will prevail at the points for which projections are made. As in the past, unemployment will be disproportionately distributed regionally, but the extent of disproportionality will diminish.

3. The projections are assumed to be free of the immediate and direct effects of wars.

4. Continued technological progress and capital accumulation will support a growth in private output per man-hour of:

   a. 3.0% annually according to OBERS 72.

   b. 2.9% annually according to OBERS 74.

5. The new products that will appear will be accommodated within the existing industrial classification system, and therefore, no new industrial classifications are necessary.

6. Growth in output can be achieved without serious environmental harm, although diversion of resources for pollution control will cause changes in the industrial mix of outputs.

The regional projections are based on the following additional assumptions:

1. Most factors that have influenced historical shifts in regional "export" industry location will continue into the future with varying degrees of intensity.

2. Trends toward economic area self-sufficiency in local service industries will continue.

3. Workers will migrate to areas of economic opportunities and away from slow-growth or declining areas.

4. Regional earnings per worker and income per capita will continue to converge toward the national average.

5. Regional employment/population ratios will tend to move toward the national ratio.

Regional assumptions 4 and 5 are corollaries of assumption 3. They are in the nature of central tendencies only. In some circumstances, they may be counterbalanced by other forces. The migration of retired people to attractive retirement areas without regard to an area's economic opportunity is an example of a countereffect.

There are other slight differences between OBERS 72 and OBERS 74, such as the rate of decline in "hours worked per year"; however, the major difference remains in the population growth rate.

The major differences between Series C and Series E population and total personal income totals are given below.

	Year 2000 Projections (millions)			
Item	Series C	Series E	Difference	Percent Difference
Population	306.8	263.8	-43.0	-14.0%
Total Personal Income (1967 dollars)	$2,542,849	$2,154,266	-$388,583	-15.3

The OBERS projections do not reflect the current energy problem, recent changes in agriculture exports, and recent changes in conservation and environmental activities.

Fertility Ratios. In 1967, the Bureau of the Census developed four population projection series--A, B, C, and D--ranging from high to low fertility assumptions. By December of 1972, the Census Bureau had abandoned projection Series A and B and added Series E and F. The four current population projections assume trends to four different fertility levels in the year 2005 with no subsequent change. The total fertility rates per 1,000 women assumed to have been attained by the year 2005 are:

Series C	2,800
Series D	2,500
Series E	2,100
Series F	1,800

Differences between the 1967 C series and the 1972 E series are insignificant through 1980 with regard to total population. If only the population 21 years old and over, the age group from which most employment is drawn, is considered, the differences between the 1967 C series and the 1972 E series do not become significant until about the year 2000, as shown in the following tabulation.

1972 E SERIES AS A PERCENT OF 1967 C SERIES

Year	Total Population	Population Age 21 and Over
1975	97.5%	100.0%
1980	95.3	100.0
1985	93.2	100.0
1990	91.1	99.6
1995	88.7	97.5
2000	85.9	94.7

The change from Series C OBERS 72 to Series E OBERS 74 is based on actual observation of current trends. (The same rule holds, of course, for the other changes.)

OBERS Methodology. The OBERS projections were made in two major steps. First, the national economy was projected by industrial groups. Second, these projected national totals were distributed regionally in accordance with projected trends in the regional distributions of economic activities.

The decision to derive regional projections through the disaggregation of national totals instead of through the independent projection of each component in each region is based on a well-established principle that the larger the area economically, the more adequate and reliable are the available statistical measures.

The principle of starting with the aggregate for the larger area--usually the nation--and disaggregating it to subareas rather than starting with the pieces and building up to the national total also applies to the projection of the industrial structure of the national economy. National all-industry measures were developed first and then disaggregated into national totals for the individual industries based on their record of contribution to the historical national aggregates.

The OBERS projections were calculated from the supply side of the economy, i.e., from a production-oriented view of the gross national product (GNP). Personal income was, however, projected independently as a major alternative to the GNP. Tables C-1 and C-2 are presented in lieu of a long explanation of the method for deriving the GNP. The tables (one for OBERS 72 and one for OBERS 74) present the derivation method as well as the data. Note that the lowest row summarizes "method of projection."

The steps of the disaggregation procedure are as follows:

1. Distinguish between "basic" or export industries, which produce goods and services exported to other areas (in essence, the generator of economic growth in an area), and "residentiary" activities, which produce goods for local consumption only.

2. Disaggregate "basic" industries according to "shift share methods"* which tend to reflect the relative advantage in production for a given industry in a given region, with respect to the national average.

3. Project "residentiary" activities. They are a direct function of the "basic."

4. Derive population from projected employment (both "basic" and "residentiary").

The OBERS projections belong to the family of "pull" models of migration, i.e., people being pulled to jobs.

However, for certain areas, particularly retirement communities, the model was adjusted in order to reflect the reality of population distribution, even if people were not attracted to jobs.

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*For a detailed explanation of this type of analysis, see Ashby.[4]

Table C-1

DERIVATION OF PROJECTED GNP AND NATIONAL PERSONAL INCOME AND EARNINGS

Year	(1) Population (thousands)	(2) Working Age Population (thousands)	(3) Total Labor Force Participation Rate (percent)	(4) Total Labor Force (thousands)	(5) Armed Forces (thousands)	(6) Civilian Labor Force (thousands)	(7) Unemployment Rate (percent)	(8) Civilian Employment (thousands)	(9) Government Civilian Employment (percent of civilian government)	(10) Government Civilian Employment (thousands)
1950	152,271	114,438	57.1%	64,749	1,850	63,009	5.3%	59,746	9.7%	6,792
1955	165,931	119,440	57.7	68,896	3,049	65,847	4.4	62,942	11.0	6,805
1960	180,684	127,335	57.4	73,126	2,514	70,612	5.6	66,681	11.9	7,948
1965	194,692	138,299	56.7	78,358	2,723	75,635	4.6	72,179	13.3	7,623
1966	196,920	140,565	57.0	80,164	3,123	77,044	3.9	74,065	14.0	10,346
1967	199,118	142,961	57.5	82,170	3,446	78,724	4.0	75,608	14.3	11,183
1968	201,166	145,405	57.6	83,681	3,535	80,152	3.7	77,210	15.1	11,627
Rate of Increase 1950-1968	1.6%	1.4%	--	1.4%	4.3%	1.3%	--	1.4%	--	3.9%
1980	235,212	174,234	58.4	101,753	3,000	98,753	4.0	94,803	16.4	15,514
2000	307,803	227,470	59.2	134,662	3,000	131,662	4.0	126,396	18.6	23,466
2020	400,053	294,956	59.8	176,427	3,000	173,427	4.0	166,490	20.8	34,572
Rate of Increase 1968-2020	1.3%	1.4%	--	1.4%	-0.3%	1.5%	--	1.5%	--	2.1%
Source of Historical Data[a]	Census	Census	Implicit	BLS	BLS	BLS	BLS	BLS	BLS	BLS
Method of Projection	Census to 2015 (p. 25 No. 381) BEA to 2020	Census to 2015 (p. 25 No. 381) BEA to 2020	Based on BLS modified by experience	Col. 2 × Col. 3	Assumed average level of 3,000,000	Col. 4 - Col. 5	Assumed 4%	Col. 6 -(Col. 7 × Col. 6)	Trend projection	Col. 8 × Col. 9

a. BLS stands for Bureau of Labor Statistics and BEA stands for Bureau of Economic Administration.

Table C-1 (cont.)
DERIVATION OF PROJECTED GNP AND NATIONAL PERSONAL INCOME AND EARNINGS

Year	(11) Private Civilian Employment	(12) Private Economy Hours Worked Per Year Per Man	(13) Private Economy Gross Per Man Product Per Hour (1958 dollars)	(14) Private Economy Gross Product (millions of 1958 dollars)	(15) Government Gross Product (millions of 1958 dollars)	(16) Gross National Product (millions of 1958 dollars)	(17) Personal Income (percent of gross national product)	(18) Personal Income (millions of 1958 dollars)	(19) Earnings (percent of personal income)	(20) Earnings (millions of 1958 dollars)
1950	53,954	2,127	$ 2.78	$ 319,410	$ 35,878	$ 355,878	77.3%	$ 274,571	82.6%	$ 226,835
1955	56,137	2,091	3.24	392,007	49,956	437,963	76.5	335,010	83.7	280,475
1960	58,738	2,027	3.68	438,523	49,159	487,682	79.9	389,653	82.1	319,781
1965	62,556	2,020	4.43	559,808	57,991	617,799	80.2	495,306	80.7	399,705
1966	63,719	2,018	4.64	596,292	61,795	658,087	80.0	526,651	81.1	427,362
1967	64,425	1,996	4.74	609,100	65,528	674,628	81.6	550,198	80.6	443,581
1968	65,583	1,977	4.93	638,998	68,610	707,608	82.0	580,030	80.4	466,191
Rate of Increase 1950-1968	1.1%	-0.4%	3.2%	3.9%	3.7%	3.9%	--	4.2%	--	4.1%
1980	79,289	1,919	7.03	1,069,096	84,777	1,153,873	84.9	979,439	79.1	774,654
2000	102,930	1,825	12.69	2,383,782	122,112	2,505,894	89.0	2,230,156	77.6	1,730,173
2020	131,918	1,736	22.92	5,248,901	174,234	5,423,135	92.0	4,987,314	76.5	3,613,710
Rate of Increase 1968-2020	1.4%	-0.25%	3.0%	4.1%	1.8%	4.0%	--	4.2%	--	4.1%
Source of Historical Data[a]	BLS	BLS	Implicit	BEA	BEA	BEA	BEA	BEA	BEA	BEA
Method of Projection	Col. 8 - Col. 10	Trend projection	Trend projection	Col. 11 × Col. 12 × Col. 13	Col. 5 ÷ Col. 9 (salary rate in 1958 dollars)	Col. 14 + Col. 15	Exponential trend projection	Col. 16 × Col. 17	Exponential trend projection	Col. 18 × Col. 19

a. BLS stands for Bureau of Labor Statistics and BEA stands for Bureau of Economic Administration.

Source: OBERS 72.

Table C-2

DERIVATION OF PROJECTED GNP AND NATIONAL PERSONAL INCOME AND EARNINGS

Year	(1) Population (thousands)	(2) Working Age Population (thousands)	(3) Total Labor Force Participation Rate (percent)	(4) Total Labor Force (thousands)	(5) Armed Forces (thousands)	(6) Civilian Labor Force (thousands)	(7) Unemployment Rate (percent)	(8) Civilian Employment (thousands)	(9) Government Civilian Employment (percent of civilian government)	(10) Government Civilian Employment (thousands)
1950	152,271	113,437	7.1%	64,749	1,650	63,099	5.3%	59,746	9.7%	5,817
1955	165,931	119,440	57.7	68,896	3,049	64,847	4.4	62,942	10.9	8,688
1960	180,671	127,357	57.4	73,126	2,514	70,612	5.6	66,681	11.9	7,913
1965	194,303	138,746	56.5	78,358	2,723	75,635	4.6	72,179	13.3	8,628
1966	196,560	141,092	56.8	80,164	3,123	77,041	3.9	74,065	14.0	10,346
1967	198,712	143,562	57.2	82,170	3,446	73,724	4.0	75,608	14.8	11,188
1968	200,706	146,033	57.3	83,688	3,535	80,153	3.7	77,210	15.1	11,627
1969	202,677	148,538	57.7	85,636	3,506	82,180	3.8	79,032	15.3	12,061
1970	204,879	151,103	57.9	87,432	3,188	84,244	5.1	79,989	15.6	12,464
1971	207,046	153,715	57.6	88,493	2,817	85,676	6.0	80,501	15.9	12,805
Rate of Increase 1950-1971	1.47%	1.46%	--	1.50%	2.58%	1.47%	--	1.43%	--	3.83%
1980	224,132	174,773	59.1	103,228	2,300	100,928	4.0	96,801	16.2	15,687
1990	246,839	190,077	59.9	113,925	2,300	111,625	4.0	107,180	17.3	18,492
2000	264,430	208,972	60.2	125,838	2,300	123,538	4.0	118,596	18.1	21,444
2010	281,968	225,343	60.5	136,353	2,300	134,063	4.0	128,700	18.2	28,468
2020	297,746	238,382	58.5	139,432	2,300	137,132	4.0	131,647	19.3	25,418
Rate of Increase 1971-2020	0.74%	0.90%	--	0.93%	-0.41%	0.95%	--	1.01%	--	1.41%
Source of Historical Data[a]	Census	Census	Implicit	BLS	BLS	BLS	Implicit	BLS	Implicit	BLS
Method of Projection	Series E explained in p. 25 No. 493	Series E explained in p. 25 No. 493	BLS	Implicit	Assumed average level of 2,300,000	Col. 4 - Col. 5	Assumed 4%	Col. 6 -(Col. 7 × Col. 6)	Trend projection	Col. 8 × Col. 9

a. BLS stands for Bureau of Labor Statistics and BEA stands for Bureau of Economic Administration.

Table C-2 (cont.)
DERIVATION OF PROJECTED GNP AND NATIONAL PERSONAL INCOME AND EARNINGS

Year	(11) Private Civilian Employment	(12) Private Economy Hours Worked Per Year Per Man	(13) Private Economy Gross Per Man Product Per Hour (1958 dollars)	(14) Private Economy Gross Product (millions of 1958 dollars)	(15) Government Gross Product (millions of 1958 dollars)	(16) Gross National Product (millions of 1958 dollars)	(17) Personal Income (percent of gross national product)	(18) Personal Income (millions of 1958 dollars)	(19) Earnings (percent of personal income)	(20) Earnings (millions of 1958 dollars)
1950	53,929	2,127	$ 2.78	$ 319,400	$ 35,888	$ 355,288	77.3%	$ 274,571	82.6%	$ 225,835
1955	56,104	2,091	3.34	392,023	45,940	437,963	76.5	385,010	83.7	280,475
1960	58,738	2,027	3.68	438,539	49,093	487,682	79.9	389,653	82.1	318,781
1965	62,556	2,020	4.43	560,096	57,703	617,799	80.2	495,305	80.7	399,766
1966	63,719	2,018	4.64	596,316	61,771	658,087	80.0	526,651	81.1	427,367
1967	64,425	1,996	4.74	609,582	65,574	675,156	81.5	550,118	80.6	443,635
1968	65,583	1,977	4.92	638,310	68,339	706,649	82.3	581,861	80.6	469,301
1969	66,971	1,967	4.98	655,994	69,633	725,627	83.8	608,033	80.5	498,148
1970	67,525	1,936	4.99	652,540	69,545	722,085	86.4	623,658	79.5	496,848
1971	67,696	1,918	5.18	672,079	69,626	741,705	86.5	641,864	78.9	506,684
Rate of Increase 1950-1971	1.09%	-0.49%	3.01%	3.61%	3.21%	2.57%	—	4.13%	—	3.90%
1980	81,204	1,858	6.70	1,010,876	80,909	1,091,785	85.9	937,592	76.5	735,825
1990	88,668	1,794	8.92	1,418,908	93,776	1,512,684	88.0	1,330,844	77.6	1,033,250
2000	97,152	1,731	11.87	1,996,179	107,204	2,103,383	89.7	1,887,092	77.1	1,454,816
2010	105,237	1,671	15.79	2,776,683	116,615	2,893,303	91.2	2,637,651	76.7	2,023,835
2020	106,231	1,813	21.02	3,601,790	125,731	3,727,521	92.4	3,443,298	76.5	2,633,637
Rate of Increase 1971-2020	0.92%	-0.35%	2.90%	3.49%	1.21%	3.35%	—	3.49%	—	3.42%
Source of Historical Data[a]	BLS	BLS	Implicit	BEA	BEA	BEA	Implicit	BEA	BEA	BEA
Method of Projection	Col. 8 - Col. 10	Trend projection	Trend projection	Col. 11 × Col. 12 × Col. 13	Col. 5 × (1958 salary rate) + Col. 9 × (1958 salary rate)	Col. 14 + Col. 15	Exponential trend projection	Col. 16 × Col. 17	Exponential trend projection	Col. 18 × Col. 19

a. BLS stands for Bureau of Labor Statistics and BEA stands for Bureau of Economic Administration.

Source: OBERS 74.

Additional Information. The basic unit of disaggregation in the OBERS projections is the county. Uniform data sources and methods of estimation were employed in constructing the area measures incorporated into the data base for each of the 2,846 metropolitan areas* and counties of the nation. As a result, the projections can be assembled in almost any geographic configuration required. For example, for the purpose of this work, data aggregated by SMSAs according to OBERS 72 were extracted from magnetic tapes stored at the Lawrence Berkeley Laboratory, University of California.

The latest report, "OBERS 74", includes actual income data for 1970 and 1971 and total employment data for 1970. In the first report, "OBERS 72", the data for those years are only an estimate. The same holds for the 1971 population data.

Industries are organized in 37 industry groups. The report does not provide distinctions between "basic" and "residentiary" industries.

Alonso Projections

In contrast to the OBERS projections which assume that people move to jobs, Alonso's method assumes that jobs move toward people. Hence, the first step is to distribute people throughout the U.S. system of localities (assuming that jobs will adjust themselves to the population distribution later). It should be noted that Alonso's model is basically a *migration* model rather than an economic growth model. Unlike OBERS, it does not deal, for instance, with industrial sectional growth. The system of localities is the 242 SMSAs defined by the Census Bureau in 1970 plus one "pseudo-SMSA" (composed of all the nonmetropolitan areas of the nation, which contained 31% of the total national population in that year). Thus, the whole U.S. is viewed as consisting of 243 elements.

The population of each locality changes from period to period by natural increases and migratory balances. Natural increase varies widely among localities but changes over time in a manner parallel to national shifts. Further, population is affected in each place by its migratory experience. Migrants tend to be young, and therefore a demographic multiplier sets in, whereby places which gain migrants experience increased birthrates, and those which lose migrants also decline in births. Migration between two localities in the U.S. depends on the characteristics and population at both origin and destination, the facility of movement between origin and destination, and the systemic alternative opportunities available from the origin and the degree of competition occurring at the destination.

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*Metropolitan areas are the 253 SMSAs as defined by the Office of Management and Budget as of January 7, 1972.

Income at a locality, on a per capita basis, is treated as responding to local opportunities and to access to the national system, as modified by local deviations. Local income is one of the factors influencing migration. It is of particular interest as an important determinant of population flows, and it is policy-sensitive through taxes, subsidies, and other government actions. Other determinants of population shifts, such as local climate and past demographic rates, are not similarly affected by policy.

The distribution of population changes over time through the flows of population movements and natural increase. Population distribution in turn affects, and is affected by, the distribution of local levels of income. Once assumptions about national futures are made in terms of natural increase and income, the model proceeds to shift populations, adjust incomes and natural increase rates, and thus forecasts future history as well as it can.

In his report, Alonso experiments with 12 policies based on federally induced increases or decreases in local per capita income, such as helping small cities, helping medium-size cities, or restraining the growth of big cities.[3]

The metropolitan per capita income (y_i), which enters as one of the independent variables into the migration equation, is defined as follows:

Metropolitan per capita income ($y_{i,t}$).

$$y_i = e^{5.01} P_i^{.066} V_i^{.087}$$

$$(.010) \quad (.023) \quad R^2 = .26$$

where:

P_i = the population in each locality in 1970

y_i = mean income per capita in locality i in 1970 dollars

V_i = population potential at locality i, defined as

$$\sum_j P_j \, d_{ij}^{-1}$$

d_{ij} = distance between localities i and j

The general logic of this relation is that local income will reflect opportunities for interacting: the more opportunities, the higher the income. Thus, local population is an indicator of such opportunities within the metropolitan areas, while V_i is a measure of accessibility to the opportunities for interaction with the rest of the metropolitan system.

A further word is necessary. Alonso used essentially constant 1970 average per capita income in running the mode to the year 2000. But real incomes have historically risen by about 2% per year. He has chosen not to incorporate such growth in the model because it would result in ever-increasing mobility, whereas historical mobility has remained fairly constant. In effect, he opted for a form of relative incomes as a determinant of mobility in order to preserve an overall rate of movement comparable to today's.

Because Alonso ignores historical per capita income growth, there is a considerable difference between his projections of national (and eventually local) per capita personal income and the corresponding OBERS projections, as demonstrated in the following tabulation which compares OBERS and Alonso on the basis of per capita income.

				Per Capita Income			
Source of Data	Year	U.S. Population (millions)	Total U.S. Personal Income (millions of 1967 dollars)	1970 Dollars	Income Converted to 1967 Dollars (× .88476)	Difference Between OBERS 74 and Alonso (1967 dollars)	Ratio: Alonso/ OBERS 74
Alonso	1970	201	not given	$3,430	$3,034.7	$ 442.1	.8728
OBERS 74	1970	203.8	$ 708.584	not given	3,476.8		
Alonso	2000	262.0	not given	3,517	3,111.7	4,999.5	.3810
OBERS 74	2000	263.8	2,154.266	not given	8,166.2		

All of Alonso's policy evaluations are based on Census population projection Series W, which assumes a fertility ratio of 2,110--the same as population projection Series E in OBERS 74.

Even though the model was originally run for all 243 metropolitan areas, data are not available at this level of disaggregation. The data were aggregated to larger areas because Alonso felt that there were too many errors at the disaggregated level. The original disaggregated data were destroyed and cannot be retrieved. Available data are available at the following levels of aggregation:

1. National
2. Nine Census divisions
3. Five urban regions (four urban regions plus one "rest of system")
4. Six categories of SMSAs
5. Seven economic development regions

Analysis and Results

Because Alonso's work in its current form lacks data for individual SMSAs, the OBERS projections (which provide data at this level of aggregation) were used as the major source of information.

The major difference between the OBERS projections and the four scenarios of this study is that the latter assume changing circumstances and instability while the former assume that the system is almost in equilibrium and that it will follow past performance.

The object of the analysis was to use Alonso's model and the descriptions of Scenarios I to IV to adjust the OBERS projections to make them as consistent as possible with the four study scenarios.

Population Distributions. With no further knowledge about population distribution, the assumption is that Scenarios I and III will follow the OBERS 74 population distribution and Scenarios II and IV will follow OBERS 72, even though they differ in their economic assumptions. In other words, it is assumed that regional differentiation in distribution of "basic" industries will follow the pattern of equilibria, even if, in fact, the system is not in equilibrium. The relative economic advantages of any region will hold also under conditions of high unemployment (such as in Scenario III). This is a strong assumption; however, it seems reasonable if one follows the pattern of current growth, which is assumed to reflect relative economic advantage.

Per Capita Income Distribution. Due to more pessimistic assumptions, all of the scenarios project lower "total national personal income" than either OBERS 72 or OBERS 74, as shown in Table C-3. The table shows the U.S. projection of total personal income according to the four scenarios and the two OBERS projections. The base year for the four scenarios is 1975.

Table C-4 shows the calculated ratio between total personal income for the U.S. for a given scenario and that of one of the OBERS projections at the national level.

Table C-3

U.S. PROJECTIONS OF TOTAL PERSONAL INCOME

	1975		1980		1990		2000
	Total Personal Income[a] (millions of 1975 dollars)	Annual Growth Rate to 1980	Total Personal Income (millions of 1975 dollars)	Annual Growth Rate to 1990	Total Personal Income (millions of 1975 dollars)	Annual Growth Rate to 2000	Total Personal Income (millions of 1975 dollars)
Scenario I	$1,193,000	3.6%	$1,423,768	3.6%	$2,027,854	2.0%	$2,471,943
Scenario II	1,143,000	2.3	1,336,652	2.3	1,677,934	2.3	2,106,353
Scenario III	1,1943,000	0.0	1,193,000	1.0	1,317,814	1.1	1,475,035
Scenario IV	1,193,000	0.0	1,193,000	1.0	1,317,814	1.0	1,455,686
OBERS 1972[b]	--	--	1,760,887	4.20	2,624,906	4.20	4,012,614
OBERS 1974[b]	--	--	1,686,086	3.49	2,394,098	3.49	3,399,431

a. Source: U.S. Bureau of Economic Analysis, *Survey of Current Business*, April 1975. (This is personal income seasonally adjusted at annual rate for the first quarter of 1975.)
b. Originally given in 1967 dollars. Multiply by 157.8 in order to obtain 1975 dollars. (1967 dollars = 100.0.)

Table C-4

RATIO OF "TOTAL PERSONAL INCOME FOR THE U.S." BETWEEN FOUR SCENARIOS AND TWO OBERS PROJECTS FOR THE YEARS 1980, 1990, AND 2000

	1980	1990	2000
Scenario I/OBERS 74	0.8444	0.8470	0.7272
Scenario II/OBERS 72	0.7590	0.6392	0.5249
Scenario III/OBERS 74	0.7075	0.5504	0.4329
Scenario IV/OBERS 72	1.0677	0.5020	0.3627

Because no further data are available for Scenarios I and III, the above ratios are applied uniformly for all disaggregated units in the system for the year 2000. For Scenarios II and IV, an attempt was made to adjust the data further according to Alonso's scheme.

The "per capita personal income" is derived from division of "adjusted total personal income" in each subarea by the appropriate population as given in the OBERS projections.

Adjusted total personal income equals total personal income as given by OBERS multiplied by the appropriate ratio as shown in Table C-4.

Tables C-5 through C-8 provide data on population, total personal income, and per capita personal income for the years 1971 and 2000 adjusted for Scenarios I and III. The data for the year 1971 in OBERS 74 are observed rather than projected; however, the data in OBERS 72 for 1970 and beyond are all projected. Hence, in all cases, the data in OBERS 74 for the year 1971 are used as a common basis.

Tables C-9 and C-10 provide data on population and personal income for the years 1971 and 2000, based on OBERS 72, and their adjustments for Scenarios II and IV, for selected SMSAs.

In making the adjustments for Scenarios II and IV, an effort was made to incorporate findings of Alonso's work--Policy 5 (help small cities within urban regions) and Policy 6 (help medium-sized cities).

In attempting to utilize Alonso's work in adjusting OBERS data to these scenarios, significant results were not obtained. The deviates from the "neutral" projection of "per capita income" in Alonso's work are generally in the magnitude of ±.3% (where 100.0% is the "neutral" projection). These small deviates have a very limited effect on the final

results. Recall that Scenario II is 52.49% and Scenario IV is only 36.27% of OBERS 72 (with OBERS 74 considered 100.0%). It is quite obvious that fine adjustments on the order of less than 1% do not add much and, hence, were not performed.

Table C-13 provides data on population and personal income (on total and per capita bases) for the years 1971 and 2000 based on OBERS 72 and OBERS 74 and their adjustments to all four scenarios, for the total U.S. and 30 subareas. The purpose of this table is to provide a comprehensible amount of data, which gives a rough description of the existing and the projected situation for the nation as a whole. The subareas are based on aggregation of states. The aggregation pattern is not based on a "rule of thumb," which tried to combine contiguous low population states with similar economic conditions (measured in terms of deviates from average national per capita personal income). Under the heading of each "zone" (in certain cases an individual state is considered a "zone") are adjusted data for each individual state within the zone.

Table C-5

NORTHEAST CORRIDOR
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 and 2000
ADJUSTED FOR SCENARIO I AND SCENARIO III

SMSA	Population (OBERS 74)		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
			OBERS 74		Adjusted for Scenario I (× .7272)	Adjusted for Scenario III (× .4339)	OBERS 74	Adjusted for Scenario I	Adjusted for Scenario III
	1971	2000	1971	2000	2000	2000	1971	2000	2000
Allentown, Bethlehem-Easton, Pennsylvania-New Jersey	551,781	624,300	$ 1,987.5	$ 5,162.0	$ 3,753.8	$ 2,239.8	$3,602	$6,012	$3,487
Atlantic City, New Jersey	180,300	207,400	597.9	1,615.8	1,174.4	710.9	3,316	5,662	3,380
Baltimore, Maryland	2,100,533	2,488,000	7,768.4	20,843.8	15,157.0	9,043.7	3,698	6,092	3,634
Boston, Massachusetts	3,756,187	4,995,000	15,411.6	46,167.1	33,572.7	20,031.0	4,103	6,720	4,009
Bridgeport-Norwalk-Stamford-Danbury, Connecticut	805,145	1,080,300	3,469.1	10,165.1	7,392.0	4,410.6	4,309	6,842	4,082
Fall River-New Bedford, Massachusetts	449,989	494,700	1,460.0	3,847.4	2,797.8	1,669.3	3,244	5,653	3,374
Harrisburg, Pennsylvania	417,572	569,200	1,496.2	4,691.1	3,344.4	2,035.4	3,583	5,992	3,576
Hartford-New Britain-Bristol, Connecticut	823,551	1,096,800	3,627.1	10,696.0	7,778.1	4,640.9	4,404	7,091	4,231
Jersey City, New Jersey	604,900	651,000	2,487.1	5,910.7	4,298.2	2,564.6	4,111	6,602	3,939
Lancaster, Pennsylvania	326,403	426,700	1,111.6	3,389.8	2,465.0	14,708.3	3,405	5,776	3,446
Long Branch-Ashbury Park, New Jersey	474,700	568,700	1,628.2	5,230.2	3,803.4	2,269.8	3,430	6,687	3,990
Manchester-Nashua, New Hampshire	235,900	330,000	808.4	2,671.6	1,942.7	1,159.2	3,426	5,882	3,509
New Brunswick-Perth Amboy-Sayreville, New Jersey	595,000	825,300	2,353.8	7,279.2	5,213.1	3,158.4	3,955	6,414	3,827
New Haven-Waterbury-Meriden, Connecticut	751,737	976,000	3,051.9	8,945.4	6,505.1	3,881.4	4,059	6,665	3,976
New York, New York	11,620,292	14,323,200	55,811.6	146,613.0	106,616.9	63,405.8	4,802	7,443	4,441

Table C-5 (cont.)

NORTHEAST CORRIDOR
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO I AND SCENARIO III

SMSA	Population (OBERS 74) 1971	Population (OBERS 74) 2000	Total Personal Income (millions of 1967 dollars) OBERS 74 1971	OBERS 74 2000	Adjusted for Scenario I (× .7272) 2000	Adjusted for Scenario III (× .4339) 2000	Per Capita Personal Income (1967 dollars) OBERS 74 1971	Adjusted for Scenario I 2000	Adjusted for Scenario III 2000
Newark, New Jersey	1,879,600	2,528,900	$ 8,253.6	$24,143.9	$17,550.7	$10,476.0	$4,391	$6,942	$4,142
Norwich-Groton-New London, Connecticut	234,051	291,300	830.7	2,416.7	1,750.9	1,048.6	3,549	6,031	3,599
Paterson-Clifton-Passaic, New Jersey	1,364,000	2,028,200	6,110.4	19,665.4	14,300.3	8,532.8	4,479	7,050	4,207
Philadelphia, Pennsylvania-New Jersey	4,905,144	6,015,000	18,852.7	52,275.4	38,014.0	22,682.1	3,843	6,318	3,770
Pittsfield, Massachusetts	151,314	194,300	562.2	1,662.6	1,209.0	721.4	3,715	6,222	3,737
Poughkeepsie, New York	226,529	352,100	869.1	3,024.2	2,199.2	1,312.2	3,818	6,246	3,726
Providence-Pawtucket-Warwick, Rhode Island	775,400	945,500	2,774.2	7,890.7	5,738.1	3,423.7	3,577	6,068	3,621
Reading, Pennsylvania	300,055	347,300	1,094.0	2,894.1	2,104.5	1,255.7	3,646	6,059	3,615
Springfield-Chicopee-Holyoke, Massachusetts	590,494	667,400	2,038.3	5,425.6	3,945.5	2,354.1	3,451	5,911	3,527
Trenton, New Jersey	310,600	459,400	1,257.3	4,143.3	3,013.0	1,797.7	4,047	5,072	3,913
Vineland, Millville-Bridgeton, New Jersey	126,700	169,800	424.0	1,409.8	1,025.2	6,117.1	3,346	5,702	3,402
Washington, D.C.-Maryland-Virginia	2,944,852	5,189,600	13,149.6	49,515.0	36,007.3	21,484.5	4,465	6,938	4,140
Wilmington, Delaware-New Jersey-Maryland	506,749	712,200	2,166.7	6,698.9	4,871.4	2,906.6	4,275	6,840	4,081
Worcester-Fitchburg-Leominster, Massachusetts	646,131	814,600	2,261.1	6,690.0	4,864.9	2,902.7	3,498	5,972	3,563
York, Pennsylvania	336,121	442,800	1,148.5	3,525.9	2,564.0	1,529.8	3,416	5,790	3,455

Table C-6

CHICAGO-ST. LOUIS CORRIDOR
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO I AND SCENARIO III

SMSA	Population (OBERS 74)		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
			OBERS 74		Adjusted for Scenario I (× .7272)	Adjusted for Scenario III (× .4399)	OBERS 74	Adjusted for Scenario I	Adjusted for Scenario III
	1971	2000	1971	2000	2000	2000	1971	2000	2000
Bloomington-Normal, Illinois	105,068	144,200	$ 380.9	$ 1,201.7	$ 8,738.7	$ 5,214.1	$3,625	$6,060	$3,616
Champaign-Urbana, Illinois	164,993	210,700	565.1	1,636.4	1,189.6	7,100.3	3,424	5,646	3,369
Chicago, Illinois	7,031,797	8,934,600	31,117.6	86,915.7	63,204.6	37,712.7	4,425	7,074	4,220
Decatur, Illinois	125,543	194,800	505.2	1,730.0	1,258.0	7,506.4	4,024	6,458	3,853
Gary-Hammond-East Chicago, Indiana	642,200	829,300	2,246.0	6,765.2	4,919.6	2,935.4	3,497	5,932	3,539
Peoria, Illinois	344,769	443,100	1,370.1	3,953.8	2,875.2	1,715.5	3,973	6,488	3,871
St. Louis, Missouri-Illinois	2,392,569	2,825,200	9,158.4	24,444.7	17,776.1	10,606.4	3,827	6,292	3,754
Springfield, Illinois	161,897	255,900	680.7	2,350.5	1,709.2	1,019.8	4,204	6,679	3,985

Table C-7

SEATTLE-PORTLAND CORRIDOR
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO I AND SCENARIO III

SMSA	Population (OBERS 74)		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
			OBERS 74		Adjusted for Scenario I (× .7272)	Adjusted for Scenario III (× .4399)	OBERS 74	Adjusted for Scenario I	Adjusted for Scenario III
	1971	2000	1971	2000	2000	2000	1971	2000	2000
Portland, Oregon-Washington	1,033,169	1,391,300	$3,906.7	$11,835.6	$ 9,606.4	$5,135.4	$3,781	$6,185	$3,691
Seattle-Everett, Washington	1,429,280	1,822,400	5,463.6	16,370.5	11,904.6	7,103.1	3,822	6,532	3,897
Tacoma, Washington	411,075	424,600	1,370.1	3,450.6	2,509.3	1,497.2	3,332	5,909	3,526

Table C-8

SELECTED CITIES
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO I AND SCENARIO III

SMSA	Population (OBERS 74)		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
			OBERS 74		Adjusted for Scenario I (× .7272)	Adjusted for Scenario III (× .4399)	OBERS 74	Adjusted for Scenario I	Adjusted for Scenario III
	1971	2000	1971	2000	2000	2000	1971	2000	2000
Los Angeles-Long Beach, California	7,031,855	9,115,700	$30,492.2	$87,206.0	$63,416.2	$37,838.0	$4,336	$6,956	$4,151
Boston, Massachusetts	3,756,187	4,995,500	15,411.6	46,167.1	33,572.7	20,031.0	4,103	6,720	4,009
Denver, Colorado	1,265,400	1,981,000	5,024.9	16,773.8	12,197.3	7,278.1	3,970	6,157	3,673
Dallas and Fort Worth, Texas	2,365,915	3,589,700	8,564.6	30,198.6	21,959.9	13,103.1	3,619	6,117	3,650
Atlanta, Georgia	1,413,709	2,465,300	5,587.9	21,013.8	15,281.2	9,117.8	3,952	6,198	3,698
Detroit, Michigan	4,254,092	5,322,600	18,100.3	50,026.4	36,379.1	21,706.0	4,254	6,834	4,078
Kansas City, Missouri-Kansas	1,266,571	1,793,300	5,065.6	15,645.0	11,377.0	6,788.0	3,999	6,344	3,785
Oklahoma City, Oklahoma	656,626	1,028,300	2,257.3	8,026.9	5,837.1	3,482.7	3,437	5,676	3,387
Billings, Montana	89,800	102,500	298.8	780.6	567.6	338.7	3,327	5,537	3,304
Fresno, California	421,935	455,700	1,535.6	3,666.2	2,666.0	159.7	3,639	5,850	3,490
Stockton, California	298,007	333,600	1,176.8	2,902.4	2,110.6	1,259.3	3,948	6,326	3,774

Table C-9

NORTHEAST CORRIDOR

POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000 ADJUSTED FOR SCENARIO II AND SCENARIO IV

SMSA	Population		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
	OBERS 74 1971	OBERS 72 2000	OBERS 74 1971	OBERS 72 2000	Adjusted for Scenario II (× .5249) 2000	Adjusted for Scenario IV (× .3627) 2000	OBERS 74 1971	Adjusted for Scenario II 2000	Adjusted for Scenario IV 2000
Allentown, Bethlehem-Easton, Pennsylvania-New Jersey	551,781	719,345	$ 1,987.5	$ 6,220.0	$ 3,264.8	$ 2,255.9	$3,602	$4,538	$3,136
Atlantic City, New Jersey	180,300	231,946	597.9	1,825.8	957.8	662.2	3,316	4,129	2,855
Baltimore, Maryland	2,100,533	3,106,320	7,768.4	27,031.0	14,188.5	9,804.1	3,698	4,567	3,156
Boston, Massachusetts	3,756,187	5,872,823	15,411.6	52,678.2	27,650.7	19,106.3	4,103	4,708	3,253
Bridgeport-Norwalk-Stamford-Danbury, Connecticut	805,145	1,239,659	3,469.1	12,523.6	6,573.6	4,545.5	4,309	5,302	3,666
Fall River-New Bedford, Massachusetts	449,989	602,979	1,460.0	4,722.0	2,478.5	1,712.6	3,244	4,110	2,840
Harrisburg, Pennsylvania	417,572	642,072	1,496.2	5,673.0	2,977.7	2,057.5	3,583	4,637	3,204
Hartford-New Britain-Bristol, Connecticut	823,551	1,501,618	3,627.1	14,156.5	7,430.7	5,134.5	4,404	4,948	3,419
Jersey City, New Jersey	604,900	815,048	2,487.1	7,531.5	3,953.3	2,731.6	4,111	4,850	3,351
Lancaster, Pennsylvania	326,403	467,776	1,111.6	3,948.5	2,072.5	1,432.1	3,405	4,430	3,061
Long Branch-Ashbury Park, New Jersey	474,700	679,887	1,628.2	5,696.5	2,990.0	2,066.1	3,430	4,397	3,038
Manchester-Nashua, New Hampshire	235,900	371,867	808.4	3,142.8	1,649.6	1,139.8	3,426	4,436	3,065
New Brunswick-Perth Amboy-Sayreville, New Jersey	595,000	882,417	2,353.8	7,719.6	4,052.0	2,799.8	3,955	4,591	3,172
New Haven-Waterbury-Meriden, Connecticut	751,737	1,152,207	3,051.9	10,663.3	5,597.1	3,867.5	4,059	4,857	3,356
New York, New York	11,620,292	16,782,841	55,811.6	174,528.7	91,610.7	63,301.5	4,802	5,458	3,771

Table C-9 (cont.)

NORTHEAST CORRIDOR
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO II AND SCENARIO IV

SMSA	Population		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
	OBERS 74 1971	OBERS 72 2000	OBERS 74 1971	OBERS 72 2000	Adjusted for Scenario II (× .5249) 2000	Adjusted for Scenario IV (× .3627) 2000	OBERS 74 1971	Adjusted for Scenario II 2000	Adjusted for Scenario IV 2000
Newark, New Jersey	1,879,600	2,916,968	8,253.6	28,765.4	$15,098.9	$10,433.2	$4,391	$5,176	$3,576
Norwich-Groton-New London, Connecticut	234,051	362,819	830.7	3,433.3	1,802.7	1,245.2	3,549	4,967	3,432
Paterson-Clifton-Passaic, New Jersey	1,364,000	2,306,667	6,110.4	24,608.4	12,916.9	8,925.4	4,479	5,599	3,869
Philadelphia, Pennsylvania-New Jersey	4,905,144	6,933,868	18,852.7	61,418.2	32,238.4	22,276.3	3,843	4,649	3,212
Pittsfield, Massachusetts	151,314	n.a.	562.2	n.a.	n.a.	n.a.	3,715	n.a.	n.a.
Poughkeepsie, New York	227,620	386,516	869.1	3,492.3	1,883.1	1,266.6	3,818	4,742	3,277
Providence-Pawtucket-Warwick, Rhode Island	775,400	1,118,932	2,774.2	9,343.4	4,904.3	3,388.8	3,577	4,123	3,028
Reading, Pennsylvania	300,055	400,453	1,094.0	3,411.9	1,790.9	1,237.4	3,646	4,473	3,090
Springfield-Chicopee-Holyoke, Massachusetts	590,494	829,093	2,038.3	6,634.4	3,482.3	2,406.2	3,451	4,200	2,902
Trenton, New Jersey	310,600	541,325	1,257.3	4,815.0	2,527.3	1,746.4	4,047	4,668	3,226
Vineland-Millville-Bridgeton, New Jersey	126,700	203,486	424.0	1,623.1	851.9	591.9	3,346	4,186	2,909
Washington, D.C.-Maryland-Virginia	2,944,852	5,003,100	13,149.6	48,126.3	25,261.4	17,455.4	4,465	5,049	3,488
Wilmington, Delaware-New Jersey-Maryland	506,749	851,415	2,166.7	8,203.0	4,305.7	2,975.2	4,275	5,057	3,494
Worcester-Fitchburg-Leominster, Massachusetts	646,131	921,955	2,261.1	7,688.1	4,305.4	2,788.4	3,498	4,377	3,024
York, Pennsylvania	336,121	507,929	1,148.5	4,156.5	2,181.7	1,507.5	3,416	4,295	2,968

n.a. = not applicable.

Table C-10

CHICAGO-ST. LOUIS CORRIDOR
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO II AND SCENARIO IV

	Population		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
					Adjusted for Scenario II (× .5249)	Adjusted for Scenario IV (× .3627)		Adjusted for Scenario II	Adjusted for Scenario IV
SMSA	OBERS 74 1971	OBERS 72 2000	OBERS 74 1971	OBERS 72 2000	2000	2000	OBERS 74 1971	2000	2000
Bloomington-Normal, Illinois	105,068	170,454	$ 380.9	$ 1,388.2	$ 728.6	$ 503.5	$3,625	$4,274	$2,953
Champaign-Urbana, Illinois	164,993	273,238	565.1	2,300.7	1,207.6	834.4	3,424	4,419	3,053
Chicago, Illinois	7,031,797	10,182,778	31,117.6	102,501.8	53,803.1	37,177.4	4,425	5,283	3,651
Decatur, Illinois	125,543	212,157	505.2	1,996.3	1,047.8	724.0	4,024	4,939	3,412
Gary-Hammond-East Chicago, Indiana	642,200	934,471	2,246.0	7,849.3	4,120.0	2,846.9	3,497	4,409	3,046
Peoria, Illinois	344,769	488,767	1,370.1	4,279.0	2,246.0	1,551.9	3,973	4,595	3,175
St. Louis, Missouri-Illinois	2,392,569	3,438,683	9,158.4	29,910.9	15,700.2	10,848.6	3,827	4,565	3,154
Springfield, Illinois	161,897	272,584	680.7	2,474.7	1,298.9	897.5	4,204	4,765	3,292

Table C-11

SEATTLE-PORTLAND CORRIDOR
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO II AND SCENARIO IV

	Population		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
SMSA	OBERS 74 1971	OBERS 72 2000	OBERS 74 1971	OBERS 72 2000	Adjusted for Scenario II (× .5249) 2000	Adjusted for Scenario IV (× .3627) 2000	OBERS 74 1971	Adjusted for Scenario II 2000	Adjusted for Scenario IV 2000
Portland, Oregon-Washington	1,033,169	1,633,259	$3,906.7	$13,969.5	$ 7,332.5	$5,066.7	$3,781	$4,489	$3,102
Seattle-Everett, Washington	1,429,280	2,480,973	5,463.6	23,420.1	12,293.2	8,494.4	3,822	4,954	3,423
Tacoma, Washington	411,075	539,185	1,370.1	4,301.4	2,257.8	1,560.1	3,332	4,187	2,893

Table C-12

SELECTED CITIES
POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
ADJUSTED FOR SCENARIO II AND SCENARIO IV

SMSA	Population		Total Personal Income (millions of 1967 dollars)				Per Capita Personal Income (1967 dollars)		
	OBERS 74 1971	OBERS 72 2000	OBERS 74 1971	OBERS 72 2000	Adjusted for Scenario II (× .5249) 2000	Adjusted for Scenario IV (× .3627) 2000	OBERS 74 1971	Adjusted for Scenario II 2000	Adjusted for Scenario IV 2000
Los Angeles-Long Beach, California	7,031,855	12,589,880	$30,492.2	$124,598.4	$65,401.7	$45,188.7	$4,336	$5,194	$3,589
Boston, Massachusetts	3,756,187	5,872,823	15,411.6	52,678.2	27,650.7	19,106.3	4,103	4,708	3,253
Denver, Colorado	1,265,400	2,197,648	5,024.9	17,945.3	9,419.4	6,508.7	3,970	4,286	2,961
Dallas and Fort Worth, Texas	2,365,915	4,540,151	8,564.6	38,501.9	20,209.6	13,964.6	3,619	4,540	3,075
Atlanta, Georgia	1,413,709	2,692,994	5,587.9	23,562.5	12,367.9	8,546.1	3,952	4,592	3,173
Detroit, Michigan	4,254.092	6,428,298	18,100.3	60,923.6	31,978.7	21,988.1	4,254	4,972	3,420
Kansas City, Missouri-Kansas	1,266,571	2,134,836	5,065.6	19,152.2	10,052.9	7,743.0	3,999	4,708	3,627
Oklahoma City, Oklahoma	656,626	1,072,094	2,257.3	8,573.4	4,500.1	3,109.5	3,437	4,197	2,900
Billings, Montana	89,800	108,662	298.8	841.0	441.4	305.0	3,327	5,248	2,806
Fresno, California	421,935	580,069	1,535.6	4,738.4	2,487.1	1,718.6	3,639	5,248	2,962
Stockton, California	298,007	399,077	1,176.8	3,453.3	1,812.6	1,252.5	3,948	5,245	3,138

Table C-13

POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000 OBERS PROJECTIONS AND THEIR ADJUSTMENTS FOR SCENARIOS I THROUGH IV U.S. TOTAL AND 30 ZONES

	Total Population (in thousands)			Total Personal Income (millions of 1967 dollars)			Per Capita Personal Income (1967 dollars)			Adjusted Per Capita Personal Income (1967 dollars)			
PROJECTION	OBERS 74	OBERS 74	OBERS 72	OBERS 74	OBERS 74	OBERS 72	OBERS 74	OBERS 74	OBERS 72	Scenario I	Scenario II	Scenario III	Scenario IV
YEAR	1971	2000	2000	1971	2000	2000	1971	2000	2000	2000	2000	2000	2000
COMMENT	--	Use for Sc.I,Sc.III	Use for Sc.II,Sc.IV	--	--	--	Col. 4 ÷ Col. 1	Col. 5 ÷ Col. 2	Col. 6 ÷ Col. 3	Col. 8 × .7272	Col. 9 × .5249	Col. 8 × .4339	Col. 9 × .3627
COLUMN NO.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
United States	206,188	263,830	306,782	$708,583	$2,154,266	$2,542,484	$3,436	$8,165	$8,287	$5,937	$4,349	$3,542	$3,005
Northern New England	2,233	2,541	3,251	6,796	19,445	25,541	3,057	7,652	7,856	5,564	4,124	3,320	2,849
Maine	1,012	1,002	1,461	2,947	7,323	10,439	--	--	--	--	--	--	--
New Hampshire	758	989	1,129	2,446	7,751	10,113	--	--	--	--	--	--	--
Vermont	453	550	661	1,403	4,371	4,990	--	--	--	--	--	--	--
Southern New England	9,789	12,677	15,166	38,298	113,116	134,432	3,912	8,922	8,864	6,488	4,652	3,871	3,215
Connecticut	3,068	4,030	4,987	12,621	37,168	46,965	--	--	--	--	--	--	--
Massachusetts	5,762	7,456	8,786	22,305	66,137	75,914	--	--	--	--	--	--	--
Rhode Island	959	1,191	1,393	3,372	9,811	11,553	--	--	--	--	--	--	--
New York	18,349	22,438	26,894	79,477	213,945	252,752	4,331	9,534	9,398	6,933	4,933	4,130	3,408
Pennsylvania	11,901	13,994	16,427	42,150	115,574	135,468	3,541	8,285	8,246	6,025	4,328	3,591	2,990
New Jersey	7,304	9,693	10,653	29,062	86,312	99,784	3,978	8,904	9,366	6,475	4,916	3,863	3,397
Delaware-Maryland-D.C.	5,318	7,476	8,176	21,461	67,156	74,763	4,035	8,982	9,144	6,532	4,799	3,897	3,316
Delaware	558	779	902	2,280	7,095	8,080	--	--	--	--	--	--	--
Maryland	4,007	5,947	6,518	15,051	50,876	58,218	--	--	--	--	--	--	--
Washington, D.C.	753	750	756	4,130	9,185	8,465	--	--	--	--	--	--	--
The Virginias	6,488	8,599	9,577	20,606	64,996	73,389	3,176	7,558	7,663	5,496	4,022	3,279	2,779
Virginia	4,720	6,782	7,436	15,652	52,739	58,967	3,316	7,776	7,929	5,654	4,161	3,374	2,875
West Virginia	1,768	1,817	2,141	4,954	12,257	14,422	2,802	6,745	6,736	4,904	3,535	2,926	2,443
The Carolinas	5,832	7,609	11,050	22,156	70,036	77,645	3,799	8,472	7,026	6,160	3,688	3,670	2,548
North Carolina	3,199	4,290	7,321	15,041	48,264	52,373	2,916	6,922	7,153	5,033	3,754	3,003	2,594
South Carolina	2,633	3,319	3,729	7,115	21,772	25,272	2,702	6,559	6,777	4,769	3,557	2,845	2,458
Kentucky and Tennessee	7,270	9,858	10,515	20,465	67,779	74,849	2,814	6,875	7,118	4,999	3,736	2,983	2,581
Kentucky	3,276	4,233	4,443	9,252	29,670	31,430	2,824	7,009	7,074	5,096	3,713	3,041	2,565
Tennessee	3,994	5,625	6,072	11,213	38,109	43,419	2,811	6,774	7,150	4,926	3,753	2,939	2,593
Georgia	4,646	6,458	7,176	14,204	46,910	52,817	3,057	7,263	7,360	5,282	3,863	3,151	2,669
Alabama and Mississippi	5,737	6,780	7,429	14,625	42,977	48,542	2,549	6,338	6,534	4,609	3,429	2,750	2,369
Alabama	3,487	4,284	4,618	9,264	27,772	31,190	2,656	6,482	6,754	4,713	3,545	2,812	2,449
Mississippi	2,250	2,496	2,811	5,361	15,205	17,352	2,382	6,091	6,172	4,429	3,239	2,642	2,238
Florida	7,026	12,713	11,767	23,537	97,004	86,673	3,349	7,630	7,365	5,548	3,866	3,310	2,671
Ohio	10,739	13,382	16,653	38,197	110,900	138,872	3,556	8,287	8,339	6,026	4,377	3,595	3,024
Michigan	8,996	11,342	13,749	34,081	97,951	119,946	3,788	8,636	8,723	6,280	4,579	3,747	3,163
Indiana	5,244	6,837	8,068	17,871	54,304	66,391	3,407	7,942	8,228	5,775	4,319	3,446	2,984
Illinois	11,182	13,877	16,033	45,513	126,826	146,667	4,070	9,139	9,147	6,646	4,801	3,965	3,317

Table C-13 (cont.)

POPULATION, TOTAL PERSONAL INCOME, AND PER CAPITA PERSONAL INCOME FOR THE YEARS 1971 AND 2000
OBERS PROJECTIONS AND THEIR ADJUSTMENTS FOR SCENARIOS I THROUGH IV
U.S. TOTAL AND 30 ZONES

	Total Population (in thousands)			Total Personal Income (millions of 1967 dollars)			Per Capita Personal Income (1967 dollars)			Adjusted Per Capita Personal Income (1967 dollars)			
PROJECTION	OBERS 74	OBERS 74	OBERS 72	OBERS 74	OBERS 74	OBERS 72	OBERS 74	OBERS 74	OBERS 72	Scenario I	Scenario II	Scenario III	Scenario IV
YEAR	1971	2000	2000	1971	2000	2000	1971	2000	2000	2000	2000	2000	2000
COMMENT	--	Use for Sc.I,Sc.III	Use for Sc.II,Sc.IV	--	--	--	Col. 4 ÷ Col. 1	Col. 5 ÷ Col. 2	Col. 6 ÷ Col. 3	Col. 8 × .7272	Col. 9 × .5249	Col. 8 × .4339	Col. 9 × .3627
COLUMN NO.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Minnesota and Wisconsin	8,333	10,133	12,063	$28,261	$81,662	$98,362	$3,391	$8,059	$8,154	$5,860	$4,280	$3,496	$2,957
Minnesota	3,860	4,900	5,673	13,225	40,236	46,798	3,426	8,211	8,249	5,971	4,329	3,562	2,991
Wisconsin	4,473	5,233	6,390	15,036	41,426	51,564	3,361	7,196	8,069	5,756	4,235	3,434	2,926
The Dakotas	1,302	1,182	1,413	3,878	8,288	9,884	2,978	7,011	6,995	5,099	3,671	3,042	2,537
North Dakota	628	545	681	1,896	3,817	4,799	3,019	7,003	7,046	5,092	3,698	3,038	2,555
South Dakota	674	637	732	1,982	4,471	5,086	2,940	7,018	6,948	5,103	3,647	3,045	2,520
Iowa and Nebraska	4,368	4,662	5,571	14,605	37,138	43,715	3,343	7,966	7,846	5,792	4,118	3,456	2,845
Iowa	2,860	3,053	3,671	9,421	24,184	28,721	3,294	7,921	7,823	5,760	4,106	3,436	2,837
Nebraska	1,508	1,609	1,900	5,184	12,954	14,994	3,437	8,050	7,891	5,853	4,141	3,492	2,862
Kansas and Missouri	6,974	8,049	9,941	23,891	63,926	80,559	3,425	7,942	8,103	5,775	4,253	3,446	2,938
Kansas	2,257	2,332	2,935	7,819	18,377	24,186	3,464	7,880	8,204	5,730	4,306	3,419	2,975
Missouri	4,717	5,717	7,006	16,072	45,549	56,373	3,407	7,967	8,048	5,793	4,224	3,456	2,919
Arkansas and Oklahoma	4,551	5,524	6,069	12,944	38,035	42,005	2,844	6,885	6,921	5,007	3,632	2,987	2,510
Arkansas	1,951	2,380	2,520	5,110	15,335	16,209	2,619	6,443	6,432	4,685	3,376	2,795	2,332
Oklahoma	2,600	3,144	3,549	7,834	22,750	25,796	3,013	7,236	7,268	5,262	3,814	3,139	2,636
Louisiana	3,693	4,021	5,015	10,242	27,294	34,944	2,773	6,787	6,967	4,936	3,657	2,944	2,526
Texas	11,428	14,632	17,188	36,265	110,813	130,281	3,173	7,573	7,579	5,507	3,978	3,285	2,748
Arizona and New Mexico	2,907	4,245	4,399	9,139	29,969	31,353	3,143	7,057	7,127	5,132	3,741	3,062	2,584
Arizona	1,862	3,065	3,063	6,198	21,918	21,777	3,328	7,151	7,196	5,200	3,777	3,102	2,609
New Mexico	1,045	1,180	1,336	2,941	8,051	9,576	2,814	6,822	7,167	4,960	3,761	2,960	2,599
Colorado and Utah	3,371	4,546	5,065	11,270	34,857	39,351	3,343	7,667	7,769	5,575	4,078	3,326	2,817
Colorado	2,277	3,134	3,473	8,060	24,986	27,914	3,539	7,972	7,054	5,797	3,702	3,459	2,558
Utah	1,094	1,412	1,592	3,210	9,961	11,437	2,934	7,054	7,184	5,129	3,770	3,060	2,605
Northern Mountains	1,784	1,744	2,063	5,485	12,881	14,776	3,074	7,387	7,162	5,371	3,759	3,205	2,597
Idaho	736	755	847	2,149	5,437	5,798	2,919	7,201	6,845	5,236	3,592	3,124	2,482
Montana	709	656	790	2,189	4,855	5,817	3,087	7,400	7,363	5,381	3,864	3,210	2,670
Wyoming	339	333	426	1,147	2,591	3,161	3,383	7,780	6,841	5,697	3,590	3,375	2,461
Northern Pacific	5,581	6,672	8,278	17,572	54,176	69,102	3,148	8,119	8,347	6,677	4,381	3,522	3,027
Oregon	2,139	2,680	3,149	7,166	20,766	24,836	3,350	7,748	7,886	5,634	4,139	3,361	2,860
Washington	3,442	3,992	5,129	12,128	33,410	44,266	3,523	8,369	8,630	6,089	4,529	3,631	3,130
California	20,286	27,049	34,298	80,260	238,676	312,969	3,956	8,823	9,125	6,416	4,789	3,820	3,309
Nevada	510	886	1,157	2,067	7,488	10,113	4,056	8,451	8,740	6,145	4,588	3,666	3,169

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